

SAE

Journal

SEPTEMBER 1959

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New elastomers break old barriers 28

Colored rubbers withstand weather indefinitely. Elastomers seal the most deteriorating hydraulic and lubricating fluids at temperatures in excess of those practical from the standpoint of the stability of the fluids themselves and the effects of heat upon metal components. The long-sought 100,000-mile tire is imminent. And the field of elastomers is yet in its infancy. (Paper No. 82U) — **Ralph P. Schmuckal**

Which way shall we produce Al cylinders? 38

Competing for the job of producing wear-resistant aluminum cylinder barrels are four production techniques. They are: wet steel sleeves, transplant coating for sleeves as well as engine block bores, cast-in sleeves, and high-wear aluminum alloys. All of these techniques make use of the economical die casting method of producing engines — and the choice between them will also depend on the economy of production consistent with good reliability. (Paper No. S201) — **A. F. Bauer**

Breakthrough—1000 F hydraulic fluid 41

A polyphenyl ether fluid will operate up to five hours at 1000 F and still be usable in a space vehicle hydraulic system, tests by Republic Aviation show. — **William E. Mayhew**

Grumman plans hydrofoil seacraft 42

Study shows feasibility, increased productivity, and design possibilities. Long-range craft will be nuclear-powered. — **Donald Lowman**

Combustion system for new diesels 46

Allis-Chalmers solved some basic combustion problems in original fashion when it designed the new direct injection diesel engines. (Paper No. 70T) — **Hans L. Wittek**

Cooling systems aren't doing an adequate job .. 54

Neglect of the cooling system, while engine power and speeds were increasing and emphasis was being placed on styling, has created a cooling problem approaching the critical. This problem will not be solved without getting back to fundamentals — to examining and improving circulation and airflow. (Paper Nos. 77T, U, V, W, X) — **C. S. Morris, J. C. Miller, R. G. Jensen, T. J. Weir, and D. H. McPherson and P. J. King**

What's needed in lubes for 2-stroke engines? .. 58

Lubrication tests with 2-stroke engines show importance of high viscosity, bright stock, thorough mixing, and detergent additives. (Paper No. 66T) — **A. Towle**

Plastics horizon for automotive use expanding .. 60

The development of new polymers offering new properties and new combinations of desirable characteristics, coupled with advances in manufacturing techniques, has expanded the plastics horizon. Still wider application now hinges in large measure on the imagination and ability used to create new products through design integration. (Paper No. 82T) — **J. H. Du Bois**

To order papers on which articles are based, see p. 6.

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Spare tire elimination still stumps experts 65

The spare tire is on its way out. The space it occupies is wanted for other purposes, particularly in that new compact car. So, the search for a satisfactory substitute is being pressed and although none has been found, tire producers are sure it will be—eventually. (Paper Nos. 79T, U, V, W) — R. P. Powers, R. E. Davies, Walter Lee, and H. B. Hindin

Solving the brake heat problem 68

The brake problem is a heat problem and the way to solve it is to design to withstand the heat, get rid of it, or use a combination of both. (Paper No. S199) — R. H. Long

Organization changes make personnel problems 70

New personnel policies and practices are needed to complement the changes taking place in organization structure of guidance and control system manufacturers. The quest for greater quality, too, is demanding personnel policy changes. (SP-327) — John Cooke

Ultrasonic fluid inspection is ultrafast 72

Ultrasonic testing equipment has inspected ALL the fluid in an aircraft hydraulic system in one-fortieth the time required for a microscopic examination of a single filtered sample. — Warren Strittmatter and Charles Albertson

Tips on designing with residual stresses 76

Two questions that designers of fatigue loaded parts must answer are: 1. What is the fatigue limit? 2. If I exceed the fatigue limit, what is the fatigue life? These questions are further complicated when there are residual stresses involved. Recent rapid testing techniques have produced guiding data for at least part of the answers to these questions, when residual stresses are present. — G. M. Sinclair, JoDean Morrow, and A. S. Ross

Radiotracers tell tales on engine wear 78

Tests at the Naval Experimental Station on submarine diesel engines showed how filtration, oil detergency level, and abrasive particle size affected piston-ring wear. They were made in two parts: (a) with a clean engine oil system, and (b) with abrasive contaminants added. (Paper No. 72T) — Harry Halliwell

Problems plague supersonic transport 84

There are problems of design, production, financing, and airport-to-city transportation. And competition from England, France, and Russia to be first will be intense. This is the consensus of a panel of aeronautical experts who discussed the supersonic transport at a luncheon session of a recent SAE meeting.

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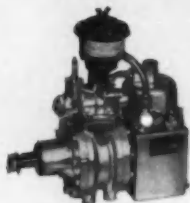
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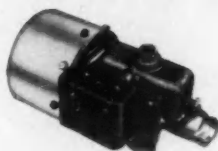
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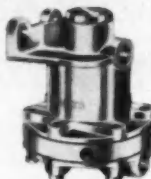
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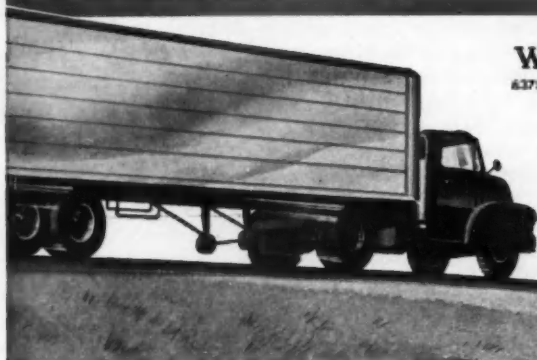
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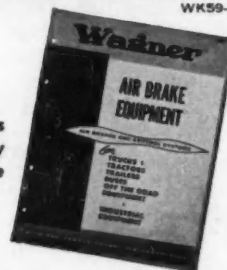
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AIRCRAFT

Optical Techniques for Collision Warning, L. H. CHASSON. Paper No. 58S. Potential effectiveness of techniques examined as basis for warning pilots of mid-air collision threats, utilizing radiation from cooperative or passive sources in visual or infrared portions of electromagnetic spectrum; performance of passive and of cooperative system; both have good potential usefulness, however, design of passive system must be very advanced to make up for lack of control of target radiation characteristics.

Approach to Organization of Air Space, J. E. BASANESE. Paper No. 58T. Approach to solution of part of Air Traffic Control Problem, viz, how to achieve optimum organization of air space; outline of general plan in four steps: to establish grid coordinate system, terminal zones, and to set up enroute tracks and enroute control centers employing large scale digital computer complexes and data display equipment; equipment requirements, ground and airborne.

Current Trends in Storable Propellants, J. SILVERMAN, S. A. GREENE. Paper No. 59R. Attributes of storable liquid systems relating to performance, instant readiness, hypergolicity, growth potential and versatility, mobility and low maintenance costs; attributes common to liquid systems; performance of some high energy cryogenic propellant systems is compared with performance of standard cryogenic system, liquid oxygen and RP-1, which powers current liquid IRBM and ICBM missiles; tables.

Some Development Problems with Large Cryogenic Propellant Systems, D. A. HEALD. Paper No. 59S. Study centers around liquid oxygen and areas discussed include variations in heat flux rate, which affect liquid density, surface condition, and replenishing re-

quirements, which may result in insufficient propellant engine operating problems, and changes pressurization requirements; development test program and flight problem.

Landing and Take Off Performance — Definition of Problem — Especially Required by SR-422A, M. B. SPAULDING, Jr. Paper No. 60R. Origin of present safety regulations; analysis of SR-422 indicates that large number of differences in philosophy are incorporated into it which never existed under CAR 4b; these differences are discussed, pointing out problems, effect and benefits of SR-422; two recommendations with respect to its clarification and operation in accordance with approved airplane flight manual, taking jet aircraft into consideration.

Jet Transport Problems During Take Off and Landing, W. E. RHOADES, R. E. COYKENDALL. Paper No. 60S. Problems of recognition, training, indoctrination, education, and public relations in order to cope with their dif-

ferent characteristics; aspects of new Civil Air Regulations under which jet transports are being certificated and operated, examined and comments made with respect to flight and field length problems.

Ways of Improving Takeoff and Landing, F. W. KOLK. Paper No. 60T. Comments on SR-422, SR-422A and SR-422B, issued by Bureau of Safety Regulation, with particular attention to BLC (boundary layer control) during takeoff and landing of jet aircraft; recommendations include installation of lead edge, high lift devices; use of turbofan type of engines; use of BLC actuated by turbine discharge gas for consideration in new designs, and direct lift jet engines to improve block speed giving VTOL capability; concept of VTOL aircraft operating from centers of metropolitan areas.

Collision Prevention Problem, F. C. WHITE. Paper No. 58R. Status of nation's effort in area of air collision prevention toward program for devel-

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SAE JOURNAL September, 1959, Vol. 67, No. 9. Published monthly except two issues in January by the Society of Automotive Engineers, Inc. Publication office at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 405 Lexington Ave., New York 17, N. Y. \$1 per number; \$12 per year; foreign \$14 per year; to members 50¢ per number, \$5 per year. Entered as second class matter, Sept. 15, 1948, at the Post Office at Lancaster, Pa., under the Act of Aug. 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of Feb. 26, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1918. Additional entry at New York, N. Y. Second class postage paid at Lancaster, Pa. and additional office N. Y. C.

oping airborne collision avoidance systems; two categories discussed; Proximity Warning Indicators (PWI), and Collision Avoidance Systems (CAS); self sufficient PWI system and its development areas; PWI attachment of airborne radar and use of infrared system; merits and shortcomings of each; type of CAS system specified by airlines and prospects for self sufficient and for cooperative CAS. 20 refs.

Thrust Magnitude Control of Solid-Propellant Rocket Motors by Mechanical Means, J. S. GATES, S. L. PINTO. Paper No. 59T. Control for motors such as are employed in ballistic missiles and space vehicles proposed and three systems presented; fundamental equations of burning rate and mass rate of flow from which control system will be derived; design offers increase in specific impulse at cold temperature, decrease in specific impulse at hot temperature, and increase in specific impulse with decreasing atmospheric pressure (increasing altitude).

Comparative Cost and Effectiveness of Manned Aircraft and Guided Missiles in Air Defense, H. K. WEISS. Paper No. 61R. Comparison of defense systems and characteristics of manned and unmanned interceptor systems; analytical procedure shows how to combine variables defining defense system on overall effectiveness/cost basis and to determine best disposition of sites and level of defense purchased with various systems; final choice must consider factors not quantitatively evaluated including offense/defense balance, system vulnerability to countermeasures, etc.

Role of Manned Systems in Aero/Astronautics, R. D. ROCHE. Paper No. 61S. Vehicles considered limited to those of next generation with capability of both aerodynamic flight and travel in space; from review of important factors supporting several primary viewpoints it is concluded that manned systems will play large role in aero/astronautics of future in following areas: military, science and psychology.

Introduction of Jet Transport, C. H. JACKSON. Paper No. 62R. Extent of operations carried out by BOAC Airlines, and studies involved, with particular reference to experience gained with various aircraft such as Comet I and IV, etc; maintenance and overhaul; fuel policy.

Lockheed Electra — What It Is, and What It Does, C. FROESCH. Paper No. 62S. Some of thinking which preceded conception of propeller driven turbine transport; basic changes made during its design to reflect airline operating experience, and anticipated requirements; service experience gained at Eastern Air Lines, Inc, and problems involved.

American's Experience With 707, M. G. BEARD. Paper No. 62T. Experience made at American Airlines, Inc., in operation of Boeing 707-123 involving seven aircraft in nonstop flight between New York and Los Angeles; review of 57 schedules, planning of take-offs, flight training of pilots, and flight planning.

NUCLEAR ENERGY

Electric Propulsion Systems, V. P. KOVACIK, D. P. ROSS. Paper No. 63S. In its simplest form these systems consist of energy source, power conversion equipment, and electric rocket; possible combinations and parameters affecting performance; component design of nuclear turboelectric propulsion system; electric power is produced by high speed generator, transformed into required form and used to produce thrust by ionizing and accelerating propellant; Rankine cycle power plant; comparison of mercury and rubidium vapor cycles.

Nuclear Rockets for Interplanetary Propulsion, F. E. ROM, P. G. JOHNSON. Paper No. 63R. Types of space mission and velocity increments required; nuclear rocket applications are divided into missions which start from Earth's surface and require thrusts greater than vehicle takeoff weight, and missions which start from satellite orbit about Earth requiring thrusts only small fraction of starting weight; particular consideration given to low power space nuclear rocket concept and estimated performance.

Electric Propulsion — Measurements with Small Thrust Plasma Generator, B. GOROWITZ, B. W. HARNED. Paper No. 63T. Data on operation of very low efficiency device for use in studying feasibility of plasma accelerating devices incorporated in small thrust electric drive for space propulsion or orientation control; T-tube employed, circuit details, and measurements made of velocity and momentum of plasma bursts both in single-shot and pulsed operation; effect of magnetic field on acceleration of plasma.

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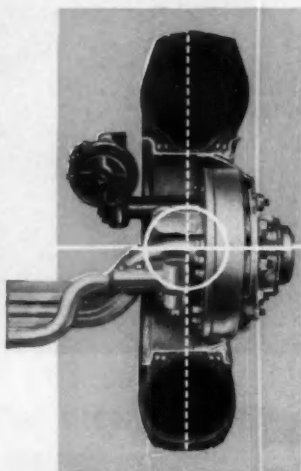
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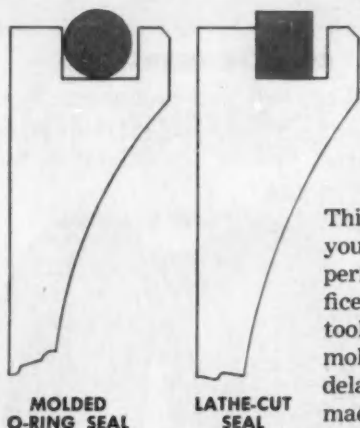
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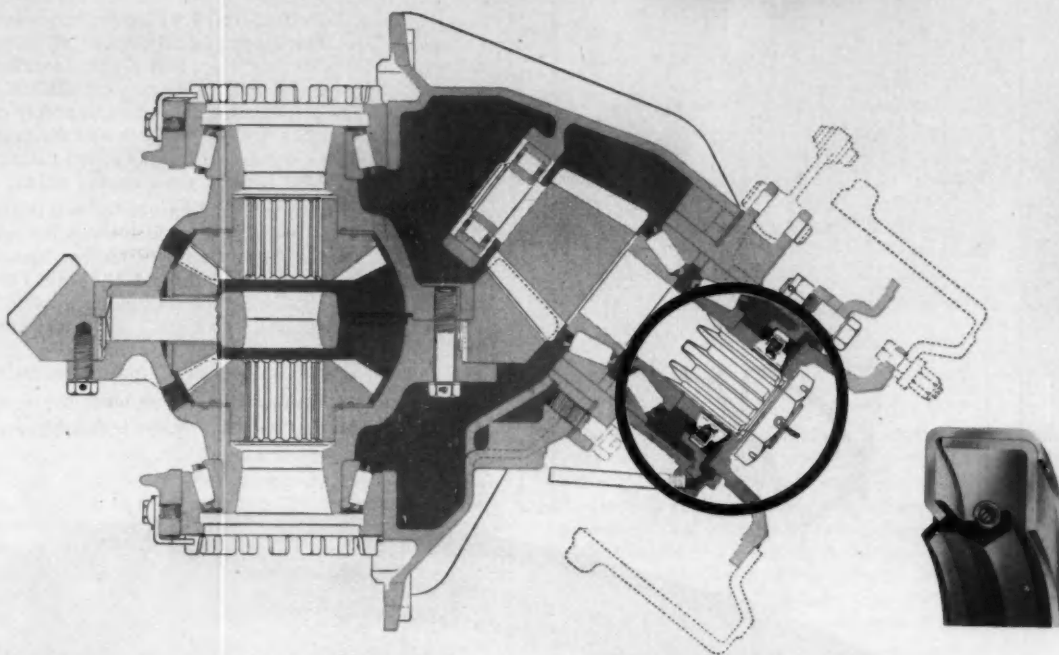


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for the Mack bus



New design seal ends grooving, eliminates costly flange replacement on bus axle carrier

In early designs of the axle carrier assembly for the new Mack bus, a combination of high temperatures, EP oils hardening the sealing lip and a relatively soft sealing surface on the flange caused grooving. It was then necessary to replace the flange, an expensive procedure.

The problem was solved through application of a new National 410,000 series synthetic rubber oil seal. The special compound of the new-design synthetic rubber sealing lip is unaffected by either high temperature or EP lubricants. To positively

insure that grooving will not cause flange replacement, an easily installed wear sleeve with synthetic rubber lining is provided.

In buses, trucks, tractors and machinery, as well as throughout American motor car manufacture, National seal engineers work with factory designers to provide better, less costly, more efficient lubricant sealing. This experience is yours at no obligation; simply call the National Seal engineer. Look under Oil Seals, in the Yellow Pages.

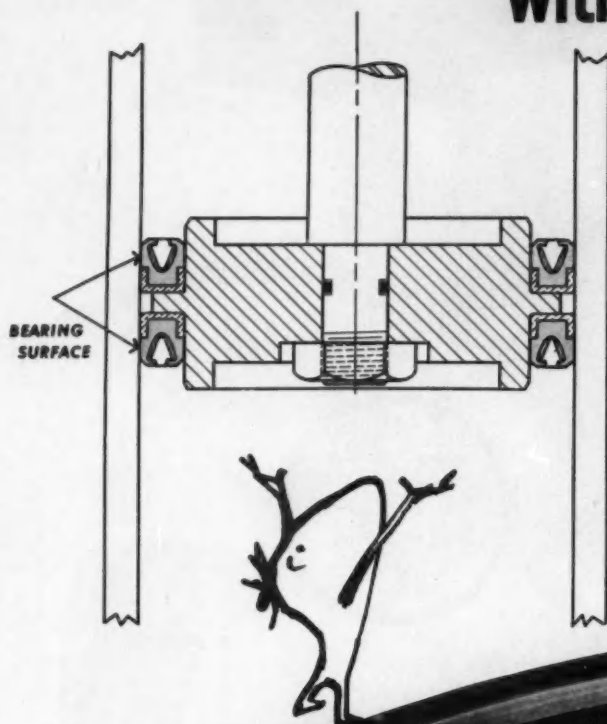
NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio; Redwood City and
Downey, California



A600

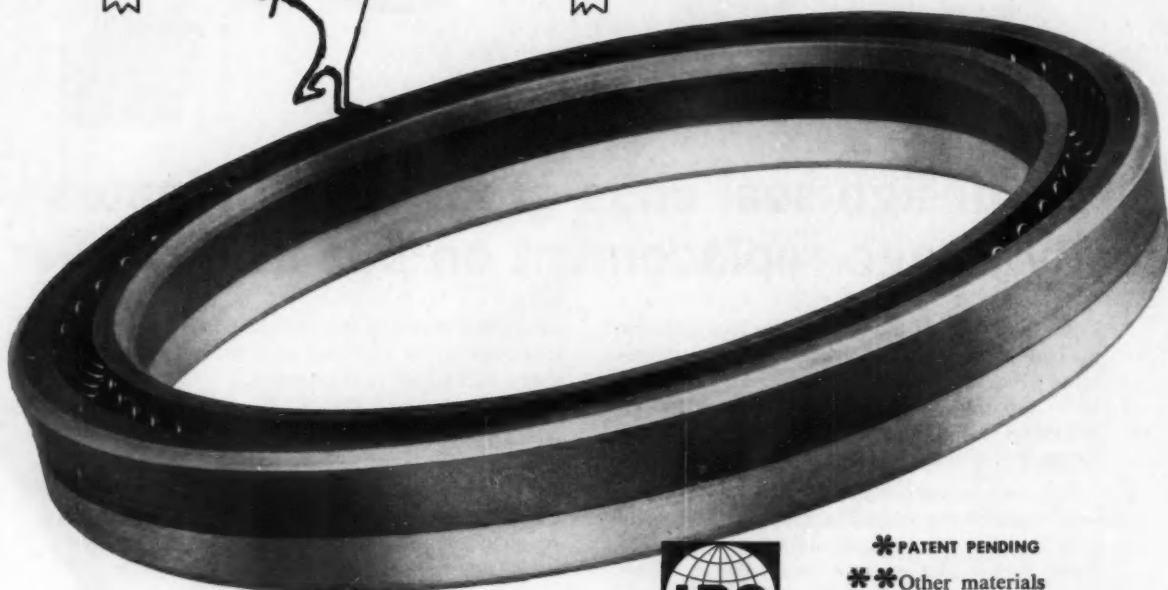
Squeeze down on expensive U-Packing Assemblies . . . with IPC's revolutionary "GUIDE-U-PAK"*. . .the packing with a built-in bearing!



A new engineering concept for hydraulic systems sealing! . . . IPC's GUIDE-U-PAK is a bonded case U packing that really puts the squeeze on expensive, complex U packing assemblies. Follower plates or back up plates with their high cost drilling, machining and fitting are eliminated. Moreover, GUIDE-U-PAK supplies its own bearing . . . riding smoothly on a close tolerance brass**case. You can end the practice of machining a wear sleeve on the piston surface, too! GUIDE-U-PAK is press fitted on the piston.

The "custom approach" in packings and seal manufacture, which typifies all IPC products, has brought this development through extensive testing. Precise manufacture means that you can specify critical tolerances for both ID and OD measurements or we will be glad to analyze your problem . . . recommend specific sizes. By establishing these limitations you can be assured of exact bearing surface and press fit.

For your next hydraulic sealing problem investigate GUIDE-U-PAK. You'll be pleasantly surprised!



OIL SEALS / PACKINGS / PRECISION MOLDING
Custom designed for your application . . .



*PATENT PENDING

**Other materials are available.
Write for details.

INTERNATIONAL PACKINGS CORPORATION

© IPC

Bristol, New Hampshire

P-6

"No Road" is no problem for this tire!

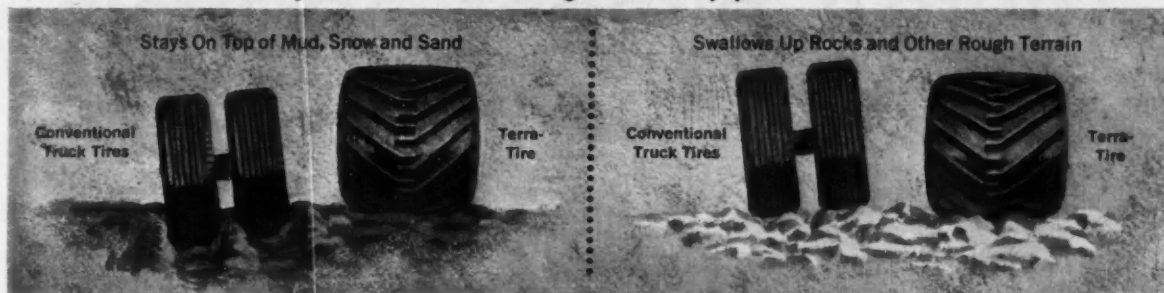


Terracruiser by FWD Corp., Clintonville, Wis.

CLIMBING EFFORTLESSLY up a 25 per cent grade with a 12-ton load on its back, this unusual vehicle—called the Terracruiser—gets much of its amazing mobility from Terra-Tires—unique, low-pressure pneumatic tires by Goodyear. Here they are cruising over 12 inches of fresh snow as part of an extensive maneuverability test conducted by the Standard-Vacuum Oil Company. Terracruisers—equipped with Terra-Tires—took every hill with ease, are now bound for oil exploration service in East Pakistan. There, the deep snow will be replaced by fluid monsoon mud and Terra-Tires will be tested under

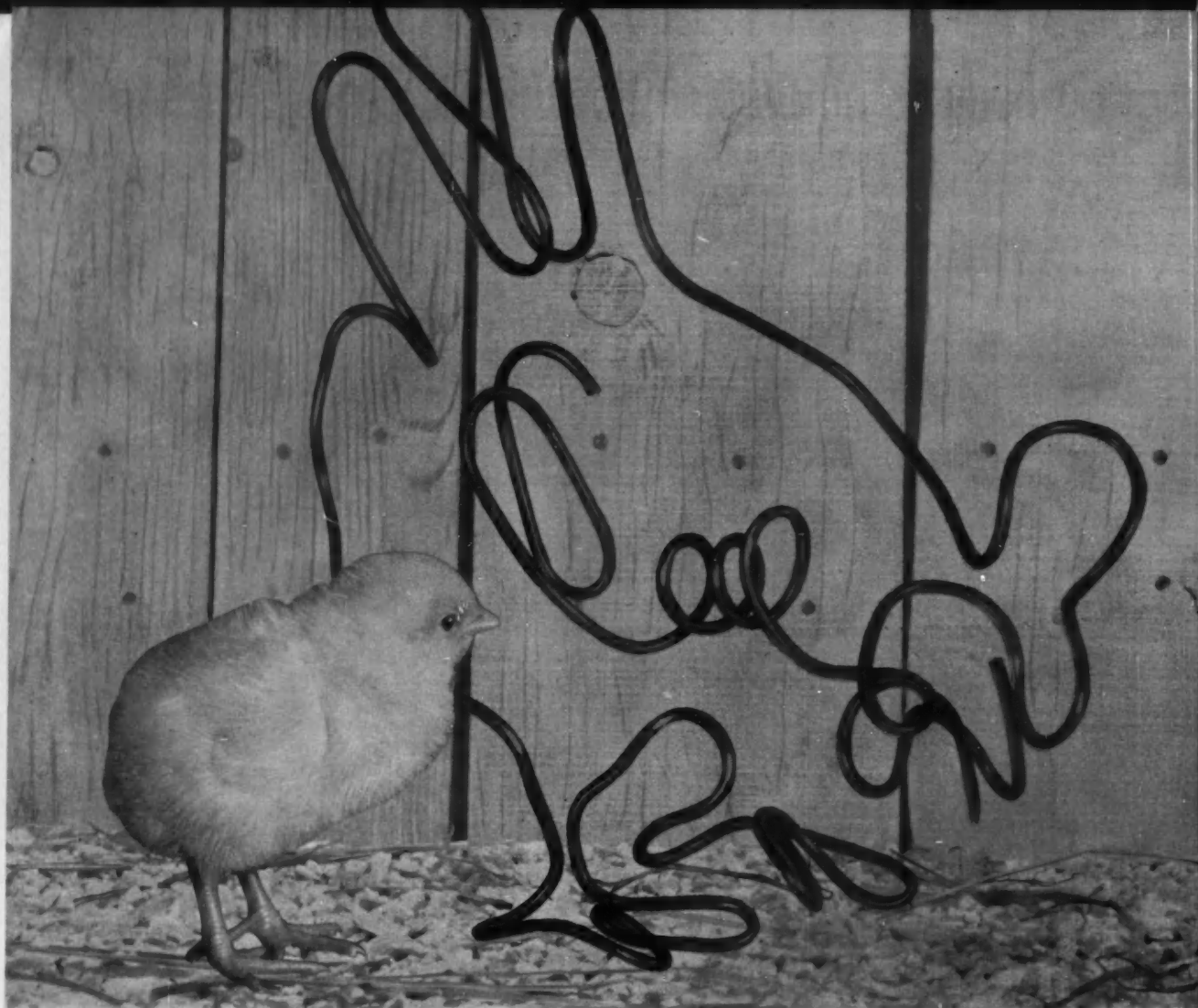
demanding conditions and over treacherous terrain. How do these tires roll with ease where conventional tires would spin and bog down? The secret: extremely wide "footprint," low ground bearing pressure and remarkable flexibility combined with exceptional strength. They actually conform to the ground contour instead of resisting it. Axle-driven and axle-loaded, Terra-Tires are now in service on golf carts, beach cleaning tractors, farm vehicles and equipment carriers of varying types. Where can these ingenious "go anywhere" tires solve a transport problem for you?

TERRA-TIRE—the Go-Anywhere Tire that is taking men and equipment where roads can never be built

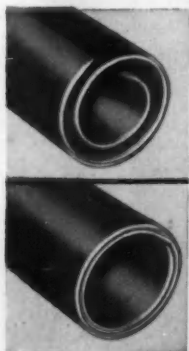


DESIGNERS: by designing vehicles from the start to utilize engineering advantages of Terra-Tire transportation, substantial savings in space and weight can be realized. For more information, call or write: Goodyear, Aviation Products Division, Akron 16, Ohio.

GOODYEAR
Terra-Tire—T.M. The Goodyear Tire & Rubber Company, Akron, Ohio
THE GREATEST NAME IN RUBBER



There's almost no limit to the things Bundy can mass-fabricate



Bundyweld is the original tubing double-walled from a single copper-plated steel strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

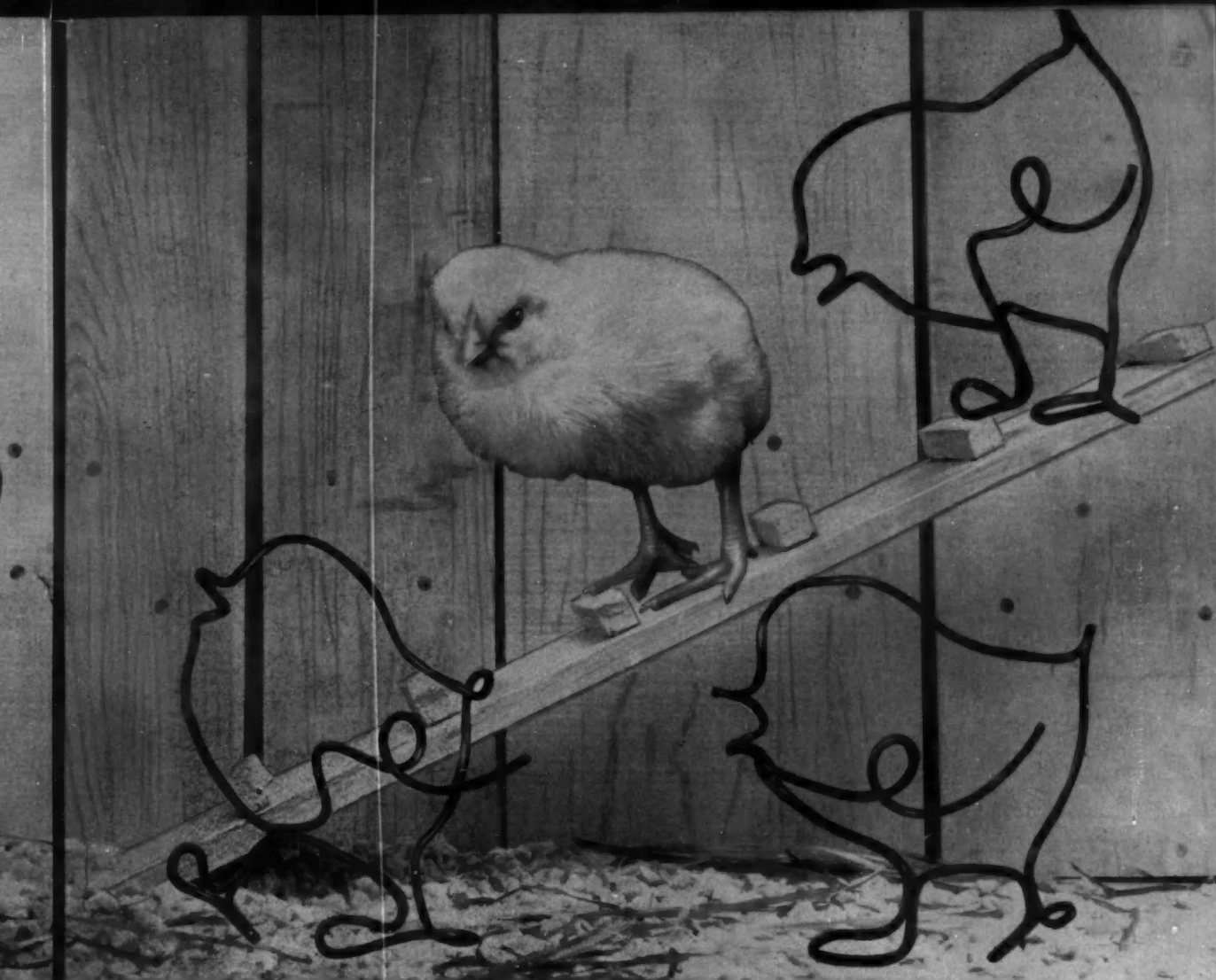
Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to 1/2" O.D.

The old adage, "Don't count your chickens before they hatch," is a good one . . . but it rarely applies to Bundy. That's because, no matter how complex your tubing problem, you *can* count on Bundy for the perfect solution.

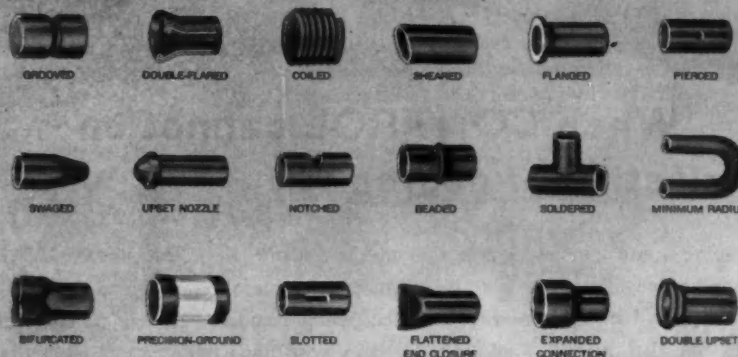
Bundy engineers and designers are backed by years of experience in the mass-fabrication of steel tubing. And they are available to you at any stage of product development for time- and money-saving suggestions. Their key: Bundyweld®!

Bundyweld steel tubing is double-walled, copper-brazed, leak-proof by test. Used on many applications in 95% of today's cars, Bundyweld is the tubing standard of the automotive industry.

So, when you want to talk tubing, talk to the leader—Bundy! Phone, write, or wire Bundy Tubing Company, Detroit 14, Michigan.



No matter what type of mass-fabrication you require, Bundyweld may be your answer. Shown here are just a few tubing operations designed and fabricated by Bundy—many for use in the automotive industry.



There's no substitute for the original

BUNDYWELD® TUBING

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING • AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, AND ITALY

BUNDY TUBING COMPANY • DETROIT 14, MICH. • WINCHESTER, KY. • HOMETOWN, PA.



When **CONTROL** cannot be a question of degree . . .

Exacting engine control believed impossible only a few years ago is now the expected, not only in modern aircraft and missiles, but also in today's automobiles and trucks. And, this absolute accuracy is demanded under temperature, pressure, and power conditions found, until recently, only in laboratories. Temperature variations alone of -80°F to $+160^{\circ}\text{F}$ require almost continuous compensations in today's jet aircraft and

missiles. More, these ever-increasing requirements must be designed for ever-decreasing standards of size and weight.

For more than a half-century, Holley has pioneered such developments as: lower automotive hood lines through smaller carburetors and fuel control systems for jet engines that save one-third the weight, one-fourth the space. That's why two generations of Americans on the move have come to depend on Holley products.

*For more information about
Holley products, automotive or
aircraft, write to*

HOLLEY
Carburetor Co.

11955 E. NINE MILE RD.
WARREN, MICH.

I-30

FOR MORE THAN HALF-A-CENTURY . . .
ORIGINAL EQUIPMENT MANUFACTURERS FOR
THE AUTOMOTIVE AND AIRCRAFT INDUSTRIES

Choose JOHNSON Solid Aluminum and Aluminum- On-Steel Bearings...

**For
Heavy-Duty
Applications**



Wherever there's a need for rugged bearings to meet your applications in diesel engines, turbo chargers, fuel injection pumps and other heavy-duty applications, you'll find quality Johnson solid aluminum or aluminum-on-steel bearings equal to the job.

Solid aluminum and aluminum-on-steel bearings carry extremely heavy loads and are rapidly becoming *standard* for heavy diesels. Both bearings have excellent embeddability properties, are ductile and have high resistance to acid formation and additive oils.

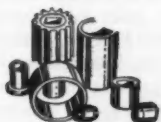
Put Johnson's years of experience in aluminum bearing design and production to work for you. Buy from the *pioneer*. Contact your Johnson representative now to get full details on how Johnson solid aluminum and aluminum-on-steel bearings can add to the life of your unit.

Johnson Bronze

675 South Mill Street • New Castle, Pa.

Subsidiary: Apex Bronze Foundry Co., Oakland, Cal.

**JOHNSON
Bearings**



POWDER METALLURGY—
BRONZE OR IRON



ALUMINUM ON STEEL
SOLID ALUMINUM



BRONZE ON STEEL



STEEL AND BABBITT



GRAPHITED BRONZE



BRONZE—
CAST OR ROLLED



Can chemical research ease the engineering squeeze?

Pressure is on the automotive engineer as never before. He is asked to make his car lower, yet put more under the hood . . . make it more powerful, but watch gas mileage. How can he do it? With the transaxle, the turbine engine, ebullient cooling, 12-inch wheels? Whatever the answers, specialized chemicals and fluids often will be needed to help make them tick. Automotive chemical research such as that now in progress at The Dow Chemical Company can be of incalculable value.

You may wish to check certain items in this advertisement and forward to those concerned in your company.

ROUTE TO:

DOW RESEARCH TRAVELS 20,000 MILES IN 1 HOUR TO IMPROVE FLUIDS

Special testing equipment in Dow's new Automotive Chemicals Laboratories determines the "shear" stability of automotive fluids in minutes instead of days. It's part of an intensive Dow development program concerned with automotive applications of chemicals from the radiator to the differential.

Viscosity index (popularly termed "V. I.") improvers are helping to open

new frontiers for automotive lubricants and future engine design. Already, viscosity index improvers are required to double as pour point depressants and detergents.

To the men of the Automotive Chemicals Section of Technical Service and Development at Dow, V. I. improvers have been a subject of research for some time. Dow comes by its interest in V. I. improvers naturally, as these additives are essentially polymethacrylate polymers. These chemicals are used in the manufacture of plastics materials, an area in which Dow has a long

history of active interest. About four years ago, Dow began to work with these polymers in terms of their automotive potential. Today, Dow is producing two new V. I. improvers and the perfection of others is proceeding at priority speed in Dow laboratories.

One of the things technicians have to determine is the "shear" stability, or breakdown point of automotive transmission fluids. Ordinarily, this is a tedious task in which the fluid must be tested in a transmission for up to 20,000 miles. A very simple but ingenious apparatus designed by two Dow engineers achieves the same result in *just one hour's time!* Several oil companies have expressed an interest in building a similar apparatus. Dow will gladly work with others interested in the problem of evaluating shear stability.

Closely related to the work in progress on V. I. improvers is research being carried out at the fuels and lubricants laboratory of Dow's Freeport, Texas division. This research on gasoline additives (both petroleum-based and synthetic) seeks better ways to prevent carbon deposits in engines, permitting use of lower octane fuels. For this and several other automotive chemical development programs, Dow has invested in a large complement of experienced technicians and specialized equipment. Primary areas of concern at present include high-density transmission fluids, differential fluids, brake fluids, and hydraulic system fluids.

By forcing fluids through precision, sharp-edged orifices under high pressure, this ingenious apparatus accurately simulates shearing forces found in the automobile.



TAKES NEW PAINT OFF THE HOOK

Several Dow chemicals already have long records of service in automotive manufacturing. One, Dow caustic soda, recently helped solve an assembly line problem. The new, tougher and more durable body paints are great for the cars, but hard on conveyor equipment. After parts pass through the spray booths, excess paint on the conveyor hooks must be stripped off before the hooks can re-enter the assembly cycle.

Dow technical service aided one alkali formulator in developing a special bath to remove the new paints. A 20% solution of caustic plus a special additive strips the hooks clean in a few minutes. An increasing number of automotive plants are now speeding operations and cutting costs with formulations containing Dow caustic soda and Dow sodium orthosilicate.



Many types of parts and equipment are cleaned with Dow caustic in auto making plants.

SPECIALIZED SOLVENTS SCORE WITH AUTOMAKERS

A new array of specialized metal cleaning solvents has replaced the old stand-bys in most automotive plants. Many of these solvents were developed by Dow for specific tasks. They are *chlorinated* solvents, characterized by an almost complete absence of fire hazard and relatively low toxicity hazard.

Two new grades of trichloroethylene, NEU-TRI* and ALK-TRI*, are widely used in vapor degreasing operations to clean gears, tappets. In fact, they do an outstanding job on all types of machined parts. Dow perchloroethylene is also used in the degreaser, particularly on white metal parts.

Chlorothene® is a new cold cleaning solvent that improves safety in cleaning electric motors, metal parts and all types of maintenance cleaning. It's even used to spot clean upholstery after inspection. Dow methylene chloride strips paints and coatings in minutes instead of hours, makes tough jobs easier and safer.

*TRADEMARK

Dow chemicals basic to the Automotive Industry

Synthetic Lubricants
Oil and Gas Additives • Antifreeze
Magnesium • Calcium Chloride
Polyols • Glycols • Hydraulic Fluids
Paint Removers • Lubricants
Caustic Soda • Plastic Molding Materials
Point and Coating Materials

THE DOW CHEMICAL COMPANY
Midland, Michigan



IDEAS INSPIRE IDEAS. Perhaps these accounts of Dow's activities in the automotive chemicals field will suggest possible solutions for your current problems. For information, write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Chemicals Merchandising Department 906EN9.

Other Areas of Automotive Activity for DOW CHEMICALS



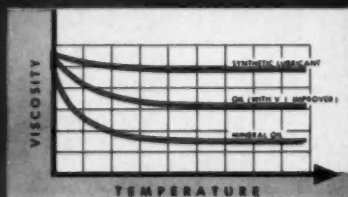
ANTIFREEZE

Research on cooling systems and cooling system fluids is a continuous project at Dow. Each year Dow technicians test hundreds of antifreeze formulations . . . advance the search for new, improved ones.



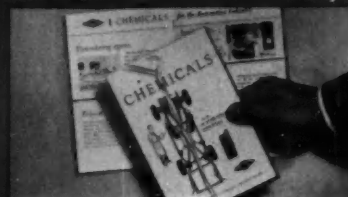
BRAKE FLUIDS

Engineers looking for new brake design ideas will be interested in Dow's brake fluid formulations. They're heavy-duty fluids that can withstand high temperatures . . . are compatible with other brake system materials.



SYNTHETIC LUBRICANTS

Research now in progress promises new synthetic lubricants that may help lower the transmission "hump" even more. Main attributes: High density, stable viscosity over wide temperature range, excellent lubricity.



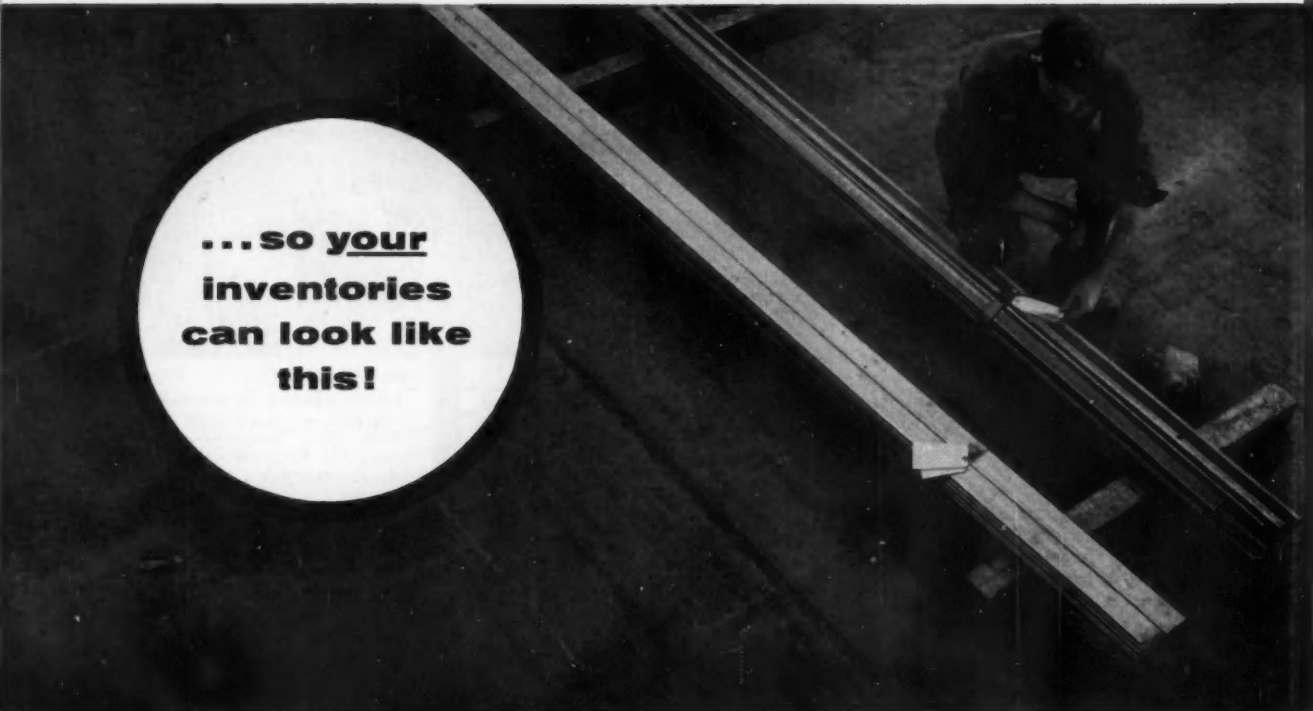
NEW AUTOMOTIVE CHEMICALS

BOOKLET — Brand new 32-page booklet describes complete line of Dow chemicals for auto industry. Organics, inorganics, developmental products plus a run-down on Dow's Automotive Chemicals Development Laboratories. Send for free copy now!



**Your
steel service
center's
inventories
look like
this**

Photos courtesy of The Universal Steel Company



**... so your
inventories
can look like
this!**

To cut inventory costs, make your Youngstown Warehouser your local "steel service center". Make full use of his complete local stocks, fast delivery service. His one-source service simplifies your purchasing and bookkeeping, too. You'll find him an efficient, time-saving, partner-in-production.



**THE
YOUNGSTOWN**
SHEET AND TUBE COMPANY

Youngstown, Ohio

Manufacturers of Carbon, Alloy and Yoloy Steel

Fleet Owners tell us

*it's the average mileage per clutch and the average cost per mile that turn **the trend to LIPE***



Fleet operators are business men first and always. Costs mean more to them than enthusiastic claims about new methods of power transmission or conversion.

They want to know! How much does the unit cost? Is it reliable? How many miles does it run between tear-downs? How many men does it take to tear it down? And what is the repair cost, not only in terms of labor and replacement parts, but in loss of capital-equipment use?

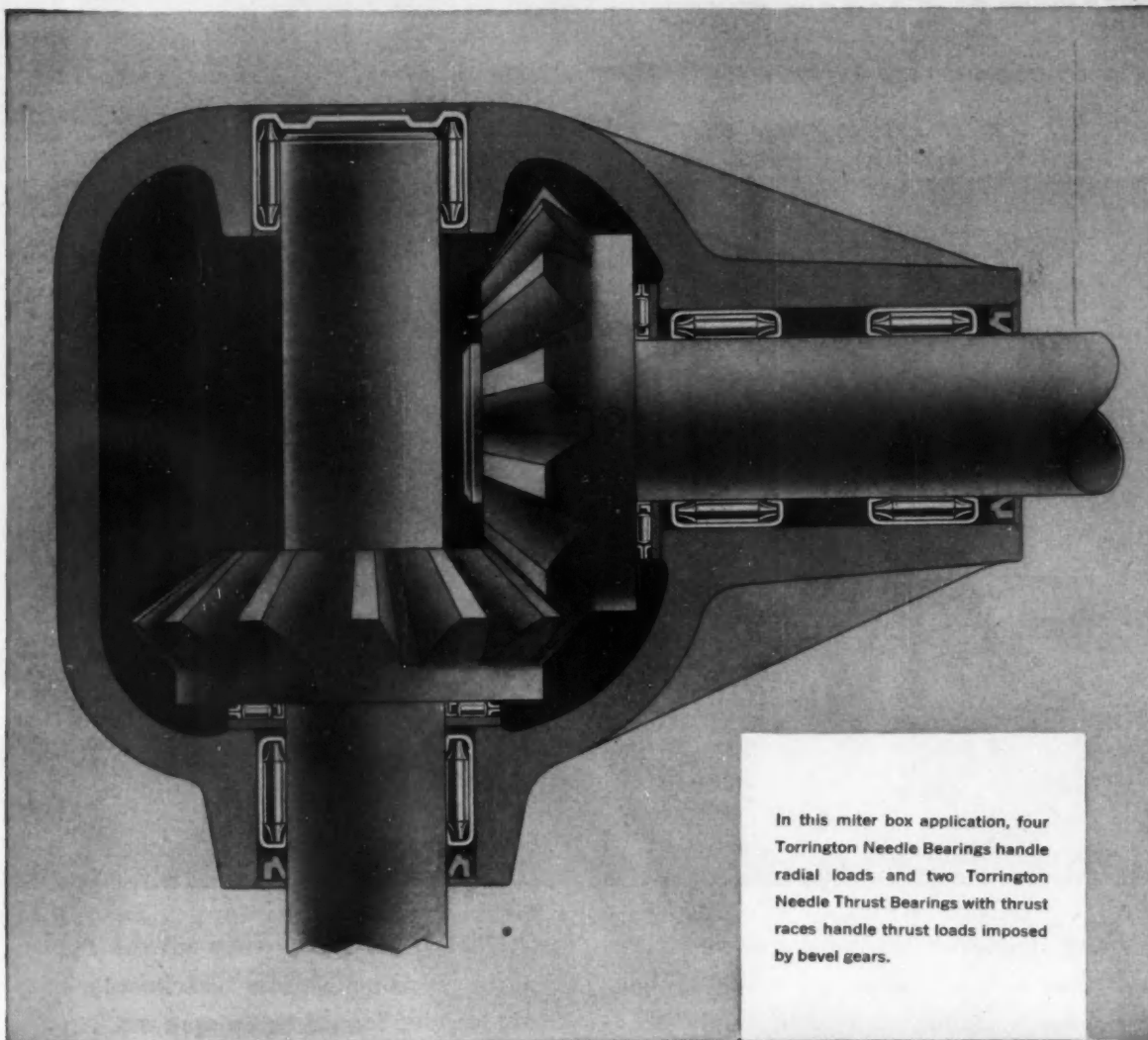
In fleet after fleet, when all the figures are in, the conclusion is inescapable. Lipe clutches give longer equipment use...more miles between tear-downs...more total mileage...all at lower average cost per mile.

Offer these fleet owners what their cost-records tell them they should buy: Lipe Heavy-Duty DPB Clutches, either as original or optional equipment. Let their growing numbers prove to you that... *the trend is to LIPE!*



Lipe Heavy-Duty DPB Clutches are available in single and two-plate types: 12", 13", 14" and 15" sizes; with torque capacities from 300 to 1900 ft.-lbs.





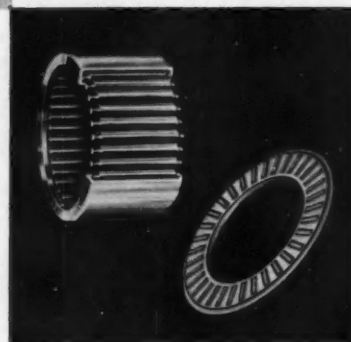
In this miter box application, four Torrington Needle Bearings handle radial loads and two Torrington Needle Thrust Bearings with thrust races handle thrust loads imposed by bevel gears.

Perfect Combination for Thrust and Radial Loads

Here's a space-saving, cost-saving way to handle high thrust and radial loads. Just team up Torrington Needle Bearings with Torrington Needle Thrust Bearings!

With their full complement of small diameter rollers, Needle Bearings handle higher radial loads than any other anti-friction bearing of comparable cross section. And Needle Thrust Bearings are only .0781" thick — as thin as an ordinary thrust washer. Together they make a perfect combination of compact, light, rugged anti-friction bearings.

Either type of bearing may be run on hardened and ground adjacent parts to meet minimum space requirements. Or they may be used with standard races available from Torrington. To make the most of this efficient combination, call on our engineering staff for application advice. **The Torrington Company, Torrington, Conn.—and South Bend 21, Ind.**



TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • BALL • NEEDLE ROLLERS • THRUST

For Sake of Argument

Under Pressure . . . ?

WE FEEL UNDER PRESSURE when we try to do too many things at once. We put ourselves under pressure, in other words, no matter how much we would like to pretend otherwise.

The possible number of demands on our time and talents is infinite. But the demands don't become pressures until we try to accede to too many of them.

Take the fellow who keeps saying "Yes, I'll try" to everybody who enters his office . . . feels an obligation to help just because he is asked. Saying "Yes" indiscriminantly is a self-imposed idea of "bearing his responsibilities."

Right across the aisle may sit another chap getting the same requests. He may have an equally high sense of obligation to make a maximum contribution, and be working hard exactly the same number of hours . . . without being under pressure.

He accepts opportunities instead of bearing responsibilities. He feels no obligation to say "Yes" . . . but a great obligation to wrap up every job in which he participates. He takes on everything he's pretty sure he can finish — on time. He spends all his "worrying time" on the projects he did take; none on those he didn't.

This chap across the aisle is mixed up in half as many projects as our "Yes, I'll try" friend, but may accomplish twice as much — net.

Besides, experience with his reliability permits associates to get more done. They have only to worry about completing their own assignments; not watch for spilled milk or dropped apples.

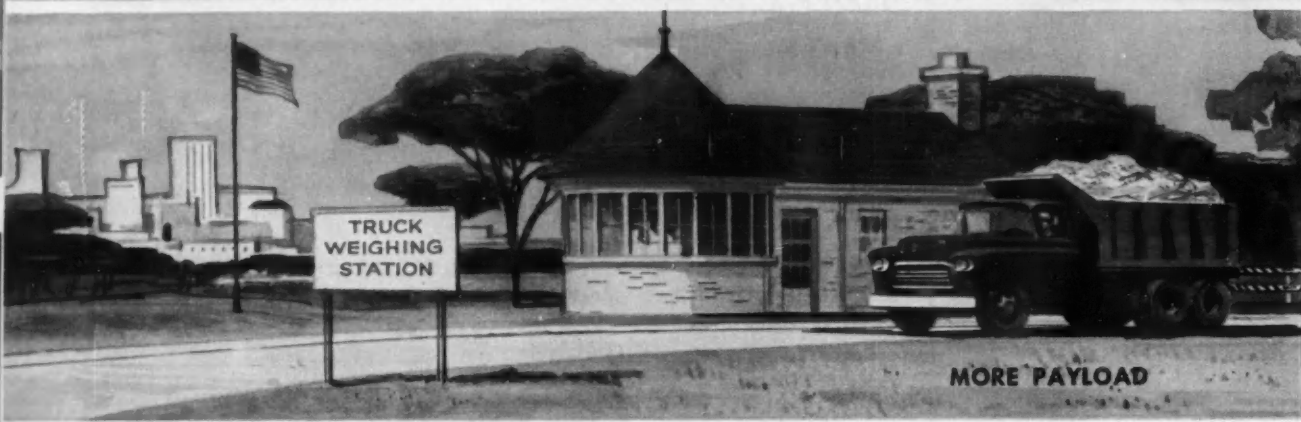
One of C. F. Kettering's famous admonitions can help each day in selecting the opportunities to go after. Remember when he said: "You can't push anything that's going faster than you are."

Norman G. Shille

REASONS WHY VACUUM POWER BRAKING IS FIRST CHOICE ON TRUCKS



ADDED SAFETY



MORE PAYLOAD



LESS FIRST COST—LOWER MAINTENANCE

WITH BENDIX HYDROVAC* LEADING ALL OTHER MAKES COMBINED

When it comes to power braking, the overwhelming choice on trucks is vacuum power, with Hydrovac leading all other makes combined.

You can bet your bottom dollar that such overwhelming preference is based on solid reasons. For example:

By saving dead weight, vacuum power can add several hundred pounds to *payload*, and earn extra dollars, as ton-miles build up.

In addition, there is the vital *safety stand-by* of instantly available physical braking, instead of "no power, no brakes!"

Then, with vacuum power there is less first cost and less expense for maintenance, and it is completely free of compressor drain on engine power.

Any way you look at it, it will pay you to make Hydrovac Vacuum Power Brakes your choice for the best in power braking . . . for the most in value.

*REG. U.S. PAT. OFF.

Bendix PRODUCTS DIVISION South Bend, IND.



NOMINEES FOR 1960 SAE BOARD OF DIRECTORS

President **H. E. Chesebrough**
Vice-President, Chrysler Corp. and General Manager,
Plymouth-DeSoto Div.

Treasurer **G. A. Delaney**
Detroit, Michigan

DIRECTORS

One-Year Term (1960)

Following were originally nominated as Vice-Presidents for one year for the Activities shown; but, under the amended Constitution and By-Laws, if elected, they will serve as Directors:

Gregory Flynn, Jr.

Head, Mechanical Development Dept., Research Laboratories, General Motors Corp. (Diesel Engine)

Joseph Gurski

Manager, Chemical and Metallurgical Laboratory Services Dept., Manufacturing Services, Ford Motor Co. (Engineering Materials)

R. R. Higginbotham

Staff Engineer — Propulsion, Applied Research and Development, Republic Aviation Corp. (Aircraft Powerplant)

H. D. Hoekstra

Chief Project Officer — Transports, Engineering and Manufacturing Div., Federal Aviation Agency (Air Transport)

R. R. Noble

Chief Engineer, Truck Design and Development, Engineering Div., Chrysler Corp. (Truck and Bus)

C. W. Ohly

Vice-President and General Manager, Thompson Products Michigan Div., Thompson Ramo Wooldridge, Inc. (Production)

F. William Petring

Chief, Vehicle Performance Branch, Bureau of Public Roads, U. S. Department of Commerce (Transportation and Maintenance)

D. J. Schrum

Body Development Engineer, Studebaker-Packard Corp. (Body)

F. Herbert Sharp

Senior Project Engineer, Convair Div., General Dynamics Corp. (Aircraft)

W. F. Shurts

Vice-President, Engineering, Twin Disc Clutch Co. (Tractor and Farm Machinery)

Gilbert Way

Research Representative, Western Region, Ethyl Corp. (Fuels and Lubricants)

J. S. Wintringham

Research Advisor, Research and Development Dept., Ethyl Corp. (Passenger Car)

Two-Year Term (1960-1961)

Following were originally nominated as Councilors for two years; but, under the amended Constitution and By-Laws, if elected, they will serve as Directors for two years:

L. C. Kibbee

Chief, Automotive Engineering Section, American Trucking Associations, Inc.

A. A. Kucher

Vice-President, Engineering and Research, Ford Motor Co.

J. R. MacGregor

Senior Research Coordinator, Products, California Research Corp.

If elected, the above members will serve on the 1960 SAE Board of Directors

★ ★ ★

Also serving on the 1960 Board of Directors will be:

DIRECTORS — Term of 1960 (Elected as Councilors for 1959 and 1960)

***H. E. Chesebrough**

Vice-President, Chrysler Corp. and General Manager, Plymouth-DeSoto Div.

T. R. Thoren

Vice-President — Engineering, Pesco Products Div., Borg-Warner Corp.

R. C. Wallace

Director of Engineering, Diamond T Motor Truck Div., White Motor Co.

PAST-PRESIDENTS:

Leonard Raymond

Chief Automotive Engineer — Research, Socony Mobil Oil Co., Inc.

William K. Creson

Consulting Engineer, Ross Gear and Tool Co., Inc.

*If elected to the Presidency, replacement to be selected by the 1960 Board of Directors

chips from SAE meetings, members,

RADIOISOTOPES USED IN WEAR TESTS alone save 75% or more in testing time and 90% in labor and material costs, according to the Council for Technological Advancement in Atomic Energy. In addition, use of radioisotopes achieves more accurate results than those obtainable by the older conventional methods.

STRESS AND FATIGUE OF CONTROL TOWER OPERATORS is being measured by Flight Safety Foundation for the Federal Aviation Agency. FSF has also taken over crash-injury studies from the disbanded Cornell research unit and is gathering data on how passengers escape from the fuselage after a crash.

NITROPARAFFINS did not demonstrate the expected high rates of reaction front propagation in spark ignition engine tests. In fact, it was about the same as for isooctane. The maximum rate for isooctane was 150 fps at an equivalence ratio of 1.15; and for nitromethane, it was 160 fps at an equivalence ratio of 1.0. Methanol had a higher maximum rate than both — 180 fps at an equivalence ratio of 1.45.

A leader must not be too far ahead of those he aims to lead . . . nor too far behind.

STOPPING AN AIRPLANE is probably the toughest braking job there is. The brake of the Boeing 707, for example, must absorb 13,000,000 ft-lb during a normal stop when the landing speed is 148 mph. On a rejected take-off stop when the speed is

173 mph, the brake must absorb 32,200,000 ft-lb. The instantaneous maximum horsepower requirement is 4750.

TOTAL AGRICULTURAL POWER CAPACITY for the USSR for 1957 is listed as 117,100,000 hp, of which 42% was from trucks and over 5% was still provided by draught animals.

The surest way to lose security is to think you can get it . . . or to seek it . . . outside yourself.

ULTRASONIC TESTING EQUIPMENT has inspected all the fluid in an aircraft hydraulic system in one-fortieth the time required for a microscopic examination of a single filtered sample.

TITANIUM CARBIDE TOOLS developed by Ford through powder metallurgy processes are lasting up to 30 times as long as conventional carbide tools.

LIVING WITHIN ONE'S MEANS — Henry Brownback of Renault says that at Renault a maximum weight is given to the designer of each unit and part of the car. That maximum then is rigidly adhered to. The designer MUST design within it. Renault's theory: "Weight is the enemy of economy."

STARTING a modern large jet engine takes as much work as stopping a 4000 lb automobile traveling 87 mph.

CORROSION is still a major problem even when the vehicle is in space. It's expected that corrosion rather than strength will limit the high temperatures needed in the radiators of nuclear powerplants used in space vehicles. These high temperatures are critical for the performance of the powerplant as the only type of continuous cooling available is direct radiation, which increases as the fourth power of the absolute temperature.

AUTOMATION can improve quality as well as quantity. Witness Renault's cylinder block line, where an important decrease in the quantity of rejects took place following automation . . . and the quantity of rejects due to fragility of parts went down to nothing, because automation avoids all shocks. (Previously fragility rejects were running 20 per day.)

HIGH-ENERGY PARTICLE ACCELERATOR development presents some challenging technical problems. For instance, the magnets for the alternating gradient accelerator now being constructed at Brookhaven must be aligned around a 483-ft-diameter circle to an accuracy of better than 0.020 in.

ABOUT 1% of all machine tools in American aircraft plants are numerically controlled.

COMPANIES can't develop a manager . . . he has to develop himself. The company's job is to set up a situation in which he can develop.

and committees

ELEVEN or 12% of Soviet cows are milked with electric-powered equipment. Whether by power or by hand, all cows are milked by women.

PPRIVATE FLYING IS BIGGER BUSINESS THAN SCHEDULED AIRLINES, expressed either in terms of passenger miles or in terms of numbers of planes. The private plane business has grown from \$16 million gross in 1951 to \$126 million gross in 1958 and is still climbing rapidly.

5-15% DOWNTIME has been experienced with numerical controlled milling machines. Approximately 3-5% of downtime is due to programming errors. About 1½% of the downtime represents preventive maintenance.

"I told you so" is stired by self-righteousness more often than by right selflessness.

A NEW PROCESS — spectacularly better and faster than the method it replaces, is developing metal alloys at Westinghouse Electric. Half a day used to be spent pouring and testing a 25-lb alloy sample. Now, controlled vacuum melting permits mixing tiny 20-gram alloy samples at the rate of 18 melts in half an hour.

Each charge (of powders containing the proper ingredients) is pressed into a small cylinder. The cylinders are arranged on a shelf in a vacuum chamber. A manipulator loads them one at a time into a funnel-shaped coil . . . When the current is turned on, the sample centers itself in the

funnel and never touches anything during the melting process. Thus it is entirely free from impurities either of atmosphere or container. . . . It is poured at controlled speed (by lowering the current in the coil) into a mold, the shape of which depending on whether the tests are for hardness, oxidation, hot rolling or forging.

In a recent 18-mo period, more than 2500 samples were analyzed — an unthinkable feat in the old two-samples-per-day era.

THE PLASMA GUN, which shoots a very hot stream of ions, appears to have possibilities for machining. Refractory metals (metals that can withstand very high temperatures) melt or go up "in smoke" rapidly when subjected to the stream of ions, but nylon — a poor conductor of heat — is disintegrated only gradually as the surface is heated, and evaporated by a process called ablation.

ARRRESTING GEAR, to stop landing roll on runways, may someday be commonplace for commercial aircraft. The problem in designing arresting gear for this purpose is to find a way to suit the tension in the snubber to aircraft of varying inertias. The Russians, although they don't use arresting gear, do regularly use a chute to stop the TU-104 transport.

"BRUISH" FIRE — The grapevine has it that George Brush of Firestone discovered and was instrumental in putting out a fire on the 15th floor of the Haddon Hall in Atlantic City. It all happened during SAE's Summer Meeting Week at A.C. The Villain — a folding cot.

MANY ENGINEERS have capacity and capability, yet fail to make the grade following promotion to a bigger job. Reason for failure: they need bifocals . . . capacity for seeing people as well as solving problems.

Writing is a vital tool in any engineering success kit — because few jobs are accomplished by one man.

STUDIES by Grumman Aircraft and its affiliate Dynamic Developments, Inc., show that hydrofoil seacraft can operate at more than three times the speed of fast displacement vessels — while maintaining the same ratio of payload to gross weight.

TODAY'S AUTOMOBILE uses over 500 rubber parts, and holds potential for hundreds more. Colored rubbers withstand weather indefinitely. Elastomers seal the most deteriorating hydraulic and lubricating fluids at temperatures in excess of those practical from the standpoint of the stability of the fluids themselves and the effects of heat upon metal components. The long-sought 100,000 mile tire is imminent. And the field of elastomers is yet in its infancy.

WE THOUGHT WE HAD HEARD THEM ALL — Latest excuse for a paper arriving late at SAE Headquarters comes from the author of a paper to be presented at SAE National Aeronautic Meeting in Los Angeles in October. "Due to an error in subroutine used in our electronic computer, which was detected only yesterday, it will be necessary to revise my paper."

New Elastomers Break

Colored rubbers withstand weather indefinitely. Elastomers seal and lubricating fluids at temperatures in excess stability of the fluids themselves and the effects of heat upon metal 100,000-mile tire is imminent. And the field of

Based on paper by

Ralph P. Schmuckal

Ford Motor Co.

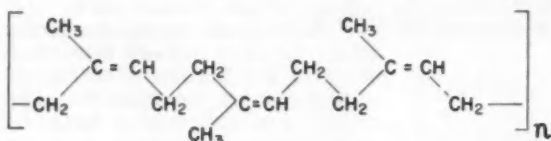


Fig. 1—CIS-polyisoprene has physical properties and polymer structure very similar to those of Hevea rubber.

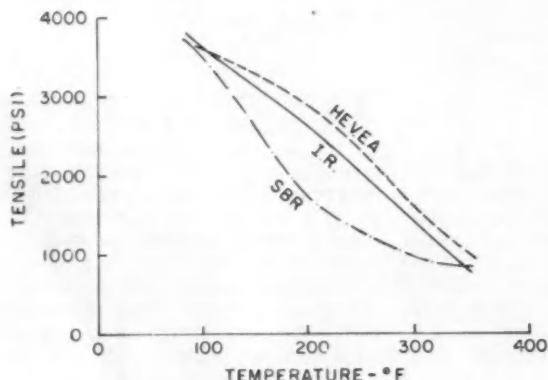


Fig. 2—Tensile strength versus temperature for isoprene rubber, Hevea, and SBR compounds.

NEW ELASTOMERS and modifications of old ones continually are being developed in the fast-moving and exciting field of nonmetallic materials. The automotive engineer adapting these elastomers to his product is exposed to myriads of claims and counterclaims, with emphasis invariably being placed on the advantages or strong points of a given material. Not too much is heard about deficiencies. Materials are made to look good. Some of them are truly remarkable. Others, due to cost or inherent weaknesses in the polymer itself, find their use rather limited in today's keen competition for a place in the automotive industry.

This article covers some of the properties and potentials of new elastomers.

Isoprene rubber

The shortage of natural Hevea rubber during World War II led to intensified efforts to develop suitable substitutes. GR-S did an outstanding job of filling the requirements of a polymer for passenger car tires and most other mechanical rubber parts formerly made of Hevea rubber. For large tires, however, GR-S was not entirely satisfactory because of excessive heat build-up. It was decided by the rubber industry that the natural rubber molecule must be built up synthetically to obtain the necessary properties of strength, elongation, abrasion resistance, processability, and the all-important low hysteresis property so necessary for such tires. Isoprene, the natural rubber monomer, became the building block for the new synthetic "natural" rubber. The work, carried on independently and simultaneously by all the major rubber companies, was highly successful and resulted in CIS-polyisoprene with physical properties and polymer structure very similar to those of Hevea rubber (Fig. 1).

Old Barriers

the most deteriorating hydraulic
of those practical from the standpoint of the
components. The long-sought
elastomers is yet in its infancy.

Isoprene rubber tire tread stocks show room temperature tensile strengths around 4000 psi with elongations in excess of 500%. Graphical comparisons for these two properties of I. R. and Hevea with a comparable SBR (formerly known as GR-S) over a wide temperature range are shown in Figs. 2 and 3. Note that I. R. and Hevea rubber have similar retention of both tensile and elongation up to 350 F. At intermediate temperatures (150-250 F), both are superior to SBR in tensile and elongation. At extremely high temperatures (350 F) all three polymers have about the same tensile, but SBR loses most of its elongation.

After heat aging at 250-300 F, I. R. retains its physical properties nearly as well as Hevea rubber.

I. R. was developed for its low hysteretic properties without sacrificing the other desirable properties of true natural rubber. Fig. 4 shows a comparison of heat build-up for I. R., Hevea, and SBR on a shear flexometer. Hysteresis of I. R. is very nearly that of Hevea rubber and less than half that of SBR.

Tire tests have confirmed laboratory data showing that CIS-polyisoprene is 95-100% as good as natural rubber for wear and for heat build-up during tire operation. It also is as good at low temperatures, giving comparable traction in ice and snow. I. R. treads have less tendency towards cracking than does natural rubber. It has been successfully tried in engine mounts and bushings for automobiles.

Commercial prospects of isoprene rubber appear very good. Widespread use has awaited the lower cost of isoprene. Indications are that in the future the cost of CIS-polyisoprene will be competitive with natural rubber but probably never as low as that of SBR.

For practical purposes, isoprene rubber may be considered identical to Hevea rubber. However,

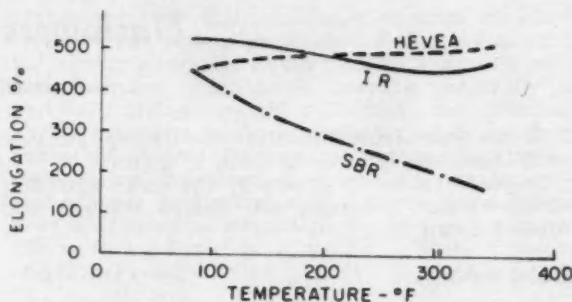


Fig. 3 — Elongation versus temperature for isoprene rubber, Hevea, and SBR compounds.

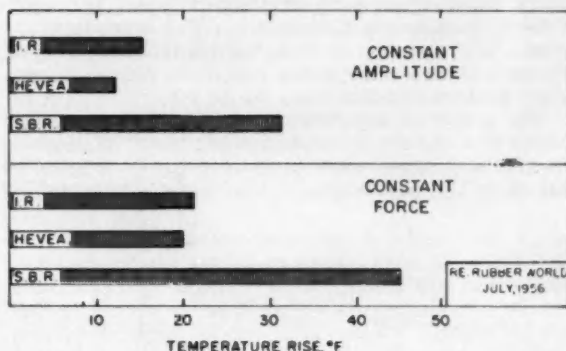


Fig. 4 — Heat build-up of isoprene rubber, Hevea, and SBR compounds as measured on a shear flexometer.

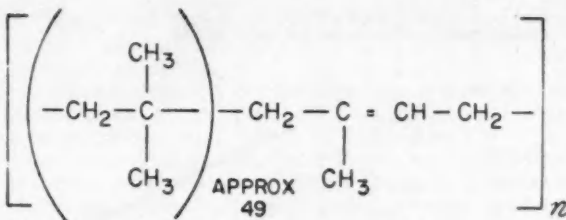


Fig. 5 — Butyl is a copolymer of isobutylene and small amounts of isoprene.

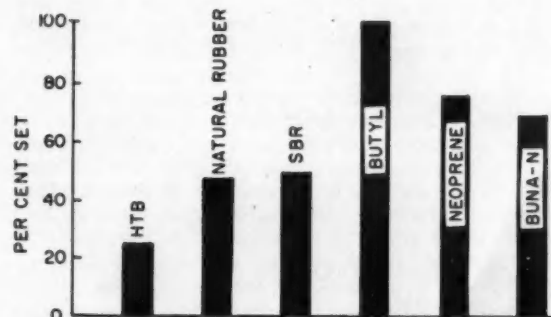


Fig. 6 — Compression set of high-temperature butyl versus other typical compounds at 300 F and 30% compression deflection.

Elastomers

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I. R. has fewer impurities than the natural polymer and, therefore, is more uniform in quality.

Isoprene rubber is known by the trade names of Coral Rubber, Ameripol SN, Natsyn Rubber, and Shell Polyisoprene.

Butyl rubbers

Conventional butyl rubber has become a widely-used general-purpose (non-oil-resisting) rubber. Chemically it is a copolymer of isobutylene and small amounts of isoprene, with a molecular structure as shown in Fig. 5. Variations in butyl polymers exist, depending principally upon the mole ratio of isoprene to isobutylene. The more isoprene used, the greater is the chemical unsaturation. Present commercial butyl polymers range in percent mole saturation from 0.9 to 2.2.

The lowest unsaturation is used where maximum ozone and chemical resistance are required, such as in wire and cable, pipe, tank linings. Care must be taken in the processing of this stock. The highest

unsaturation is fastest curing, easiest processing, and is used primarily where heat resistance is required, such as in curing bags and bladders, carcass and tread base compounds for tires.

Intermediate grades represent compromises in physical properties and are widely used or finding use in such items as inner tubes, weatherstrips, suspension bumpers, convertible tops, hydraulic seals, and such.

Some desirable properties of butyl are:

1. Good heat resistance.
2. Good ozone and weather resistance.
3. Low permeability to gas.
4. Good tear resistance.
5. Good flex resistance.
6. Good resistance to synthetic fluids, such as ester and glycol types which are very polar in nature.
7. Good colorability (in molded items).
8. High damping characteristics.

A few of the shortcomings of butyl are:

1. Only fair compression set characteristics.
2. Low resilience at normal and low temperatures.
3. Poor resistance to mineral oils and fuels.
4. Incompatibility with other elastomers.
5. Somewhat difficult processing characteristics.
6. Only fair low-temperature properties.

Much published information is available on conventional butyl rubber—its chemistry, properties, and applications. Not so well known are some of the more recent modifications of butyl which overcome some of the above mentioned shortcomings.

Halogenated Butyl

Halogens, such as bromine and chlorine, added along the butyl chain make important improvements in the properties of butyl. Polymers with 1.0 to 3.5% bromine have significantly increased cure rates and are compatible with other elastomers. This modified butyl actually can be blended with natural rubber and synthetics to give desirable properties of each material. Conventional butyl cannot be blended in any such manner; in fact, processing butyl in proximity to other more unsaturated type materials like SBR, Buna-N, and Neoprene is difficult because small amounts of such polymers rob the system of vulcanizing agent and prevent proper curing of the butyl.

In mixtures with natural rubber, bromobutyl reduces the tensile strength of natural rubber but not below a respectable value. The gas diffusion rate through natural rubber or SBR is greatly reduced by bromobutyl, decreasing linearly with increasing bromobutyl ratios up to a 50-50 mixture. Likewise, ozone resistance of SBR and natural rubber are appreciably improved by blending with bromobutyl.

Brominated butyl exhibits adhesion to metals and other rubbers superior to that of conventional butyl.

Because of its adhesive qualities, low gas permeability, and compatibility with other elastomers, bromobutyl is used in the tire industry in inner liner compounds for SBR tubeless tires. It retains air like butyl rubber and adheres to the carcass like SBR or natural rubber. Bromobutyl rubber is used as a ply to retread an SBR tire with butyl tread. The polar halogen atom apparently accounts for its compatibility.

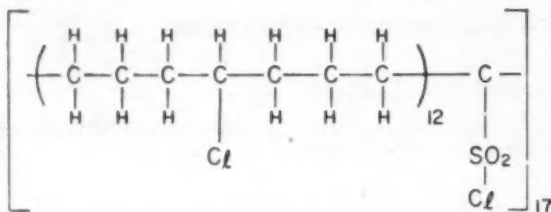


Fig. 7—Chlorosulfonated polyethylene is made by reacting polyethylene plastic with chlorine and sulfur dioxide.

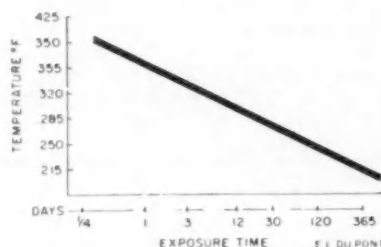


Fig. 8—Heat aging of chlorosulfonated polyethylene; time to drop elongation to 100%.

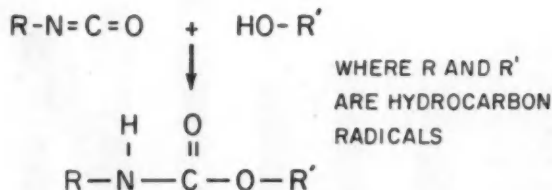


Fig. 9—Urethane is formed by the reaction of an isocyanate group of one material with the hydroxyl group of another. Cross-linking or polymerizing this urethane into large, complex molecules completes the process of forming the urethane elastomer.

Chlorobutyl rubber, similar chemically and physically to bromobutyl, is a new polymer consisting of the basic butyl polymer with 1.1 to 1.3% chlorine (by weight) attached along the chain. It is uncertain at present whether it attaches to the double bond or replaces hydrogen atoms of the CH_2 or CH groups. Today it is being produced in pilot plant quantities only, and has not been fully evaluated for specific uses. Like bromobutyl, it is compatible with other elastomers, has good adhesive qualities and air holding properties. With a sulfur cure system, tensile strengths of 2800 psi and elongations of 300 to 400% are obtained.

With chlorobutyl, an unusually large number of cure systems are available, each imparting somewhat different properties to the vulcanizate. The wide selection of cure systems and blending possibilities with other elastomers make it possible to produce compounds covering an extremely wide range of physical properties and to accentuate certain properties in a given compound. Some chlorobutyls have exceptional ozone resistance, others unusually high heat resistance, flexing performance, tear strength, compression set, or abrasion resistance. Laboratory tests indicate certain chlorobutyl compounds and blends of chlorobutyl and butyl to have abrasion resistance twice that of regular butyl tire tread stock. It appears, therefore, to have great potential as a tire material. Another interesting feature of chlorobutyl is that oil resisting materials like Buna-N and Neoprene can be blended with it to improve its oil resistance without sacrificing too much the desirable qualities of butyl.

Chlorobutyl's low temperature and damping properties are comparable to those of butyl.

Chlorobutyl, in addition to being a specialty material, may become a general purpose elastomer. Possible applications are molded items requiring good high-temperature service, such as gaskets, couplings, ring seals, brake boots, vibration dampers, spark plug boots, hoses, and similar applications where only a small degree of oil resistance is required.

High-Temperature Butyl

High-temperature butyl, sometimes referred to as "resin-cured" butyl, is not a new polymer, but the product of a development in curing systems of the butyl polymer. Phenol resins act as the vulcanizing agents. This cure imparts unusual thermal stability, ozone resistance, and compression set to the butyl polymer.

The top temperature for continuous exposure to dry heat has been raised to 350 F. Periodic exposure to peak temperatures of 400 F or even 450 F can be tolerated. Such performance rates it well above such elastomers as natural rubber, SBR, Buna-N, conventional butyl, and neoprene. Fig 6 shows this heat resistance in a different manner, by comparing its compression set properties, at 300 F and 30% deflection, with other well-known polymers. The graph indicates that at 300 F the compression set of high-temperature butyl is only about one-quarter that of standard butyl. High-temperature butyl at 300 F is as good as conventional butyl at room temperature.

Resin curing does not significantly alter the

rather poor oil and gasoline resistance of butyl. Nevertheless, this material should find use as seals for certain hydraulic fluids, possibly engine mounts and bumpers, elastomeric backing materials to maintain preload, gasket materials, and mechanical rubber parts in the engine compartment of an automobile where electrical properties, heat resistance, ozone resistance, and possibly abrasion resistance are requirements, but where the material does not come into continuous contact with mineral oils or fuels. Spark plug boots and brake cups are additional possibilities.

Chlorosulfonated polyethylene

Chlorosulfonated polyethylene has been available for several years; nevertheless, it is considered by the automotive industry as a specialty material that slowly but continually is finding wider usage.

Chlorosulfonated polyethylene is made by reacting polyethylene plastic with chlorine and sulfur dioxide. The resulting molecular structure is shown in Fig. 7. This material, unlike thermoplastic polyethylene, is vulcanizable with properties of a true elastomer.

This material is noted for its resistance to heat, ozone, weather, abrasion, and chemicals. Color stability is excellent.

Its heat resistance may best be shown by a plot of temperature versus exposure time to reduce the elongation to 100% (Fig. 8). At 100% elongation the material is considered still sufficiently elastomeric for most service applications. Note, for example, that the service life at 350 F is over one day; at 300 F, about 9 days; at 250 F, about 3 months, and so on. This is under continuous, unprotected exposure to hot air. Such resistance to heat is considerably better than that obtained with neoprene which also is considered to be a good heat-resisting material. To make a direct comparison, neoprene, aged 9 days at 300 F, would have less than 20% stretch remaining.

Chlorosulfonated polyethylene is completely unaffected by ozone, even at elevated temperatures and extremely high ozone concentrations.

Its chemical resistance may be summarized as follows: Outstanding resistance to acids and strong oxidizing agents such as sulfuric acid and hydrogen peroxide. Good resistance to nonoxidizing chemicals, such as ethylene glycol, alkalies, and such. Resistance to mineral oils nearly equal to that of neoprene. It is unsuitable for direct contact with gasoline and aromatic solvents.

Weather resistance is very good, even for light colored materials. Exposure in Florida for 2½ yr resulted in no noticeable color change or significant loss in physical properties.

Regarding its low-temperature properties, practical vulcanizates stiffen at somewhat higher temperatures than more conventional elastomers. The 10,000 psi (Clashberg) modulus occurs in the neighborhood of 0 F. However, by special compounding and at some sacrifice of other desirable properties, this degree of stiffening may be reduced to temperatures as low as -60 F. It has an extremely low brittle point, even for compounds that stiffen at relatively high temperatures. Brittleness usually is encountered in the range of -60 to -100 F.

Many rubber fabricators have resisted the use of

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chlorosulfonated polyethylene because of difficulties in processing this material in their plants. This may have contributed in part to the development of a new chlorosulfonated polyethylene to be introduced commercially in the near future. Its primary advantages over the currently used material are its oil resistance, which is comparable to that of neoprene, its greater strength, and its much improved processability.

With these properties, chlorosulfonated polyethylene should find use in the automotive industry. Its ozone, heat, and oil resistance, together with good electrical properties and abrasion resistance, make it a desirable material for spark plug boots, ignition wires, white sidewalls of tires, convertible topping, weatherstrip coatings, coatings for urethane foam headliners, and truck tarpaulins. The present trend to colored material also may bring about a demand for colored windshield wipers and colored window weatherstrips, possibly of this material, in the future.

Chlorosulfonated polyethylene is marketed under the trade name, Hypalon.

Urethane rubber

Solid urethanes constitute a large family of materials produced basically by combining diisocyanates with polyesters or polyethers, followed by curing or crosslinking with peroxides, amines, glycols, heat, and such. The chemistry is similar to that used in producing urethane foams, but without the blowing agent that produces the cellular structure.

The basic, essential reaction to form a urethane is the reaction of an isocyanate group of one material with the hydroxyl group of another (Fig. 9). Crosslinking or polymerizing this urethane into large, complex molecules completes the process of forming the urethane elastomer.

Many varieties of urethanes with a wide range of physical properties are produced. Adiprene-L and Vulcollan are liquid, castable types. Adiprene-C is a gum-type polymer, processable on conventional rubber processing equipment. Unlike the liquid types, Adiprene-C can be reinforced with fillers like carbon black. Similar or modifications of these urethanes are commercially available under the trade names Genthane, Vibrathane, Estane, Daykollan, and Chemigum SL.

For the automotive engineer, this material can be described best in terms of its physical properties, as follows:

Hardness: Urethanes are fairly hard materials, usu-

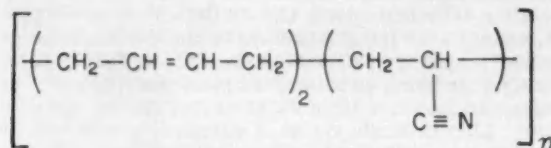


Fig. 10—Buna-N, the most common nitrile rubber, is a copolymer produced from building blocks of butadiene and acrylonitrile.

	% Tensile Change	% Elong Change	% Volume Change
AIR @ 300 F	-21	-14	
350 F	-85	-48	
ASTM #3 @ 300 F	-2	+14	+17
350 F	-4	+14	+17
ASTM #4 @ 300 F	-1	+43	-2
350 F	+43	-52	-8

Fig. 13—Effect on typical polyacrylic rubber seal stock of aging one week in various media.

ally falling in the 60 to 98 Shore A durometer hardness range, with 80 to 90 durometer most common. **Tensile:** Tensile strengths from 4500 to 7500 psi are not uncommon. In general, the harder the stock, the higher the tensile.

Elongation: Percent elongation on most stocks is exceptionally high—400 to 750%. One available stock of 80 durometer hardness and 7280 psi tensile elongates 640%. Its elastic properties are exemplified by the fact that its elongation set, after this high stretch, is only 20%.

Tear: Tear strengths also are remarkably high and, in general, increase as hardness values increase—ranging from about 250–700 lb per in. Compare this with about 300 lbs per in. for a high tear strength neoprene.

Abrasion Resistance: Laboratory accelerated wear tests show from three to ten times the wear of other synthetic rubbers or natural rubber.

Ozone Resistance: Ozone resistance is excellent. Slight surface cracking after 16 hr in the abnormally high ozone concentration of 10,000 ppm (parts per hundred million) is typical. Outdoor weather conditions will not degrade urethane, but do tend to discolor it.

Heat Resistance: Urethane is not materially affected by dry air temperatures up to 212 F. About 250 F should be considered the upper limit of serviceability.

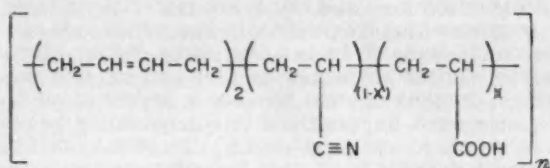


Fig. 11—Carboxylated Buna-N is a medium high acrylonitrile copolymer which has been modified to include carboxylic groups in the polymer chain.

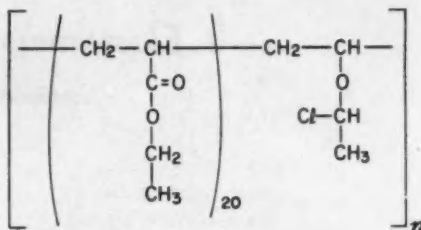


Fig. 12—The most widely used polyacrylic rubber, commonly referred to as PA rubber, is a copolymer of 95% ethylacrylate and 5% 2-chloroethylvinyl ether.

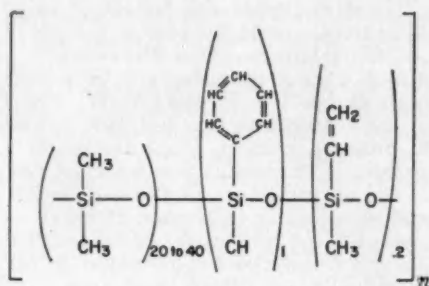


Fig. 14—High-tensile silicone is a dimethyl siloxane polymer with some methyl groups replaced with phenyl and vinyl groups.

	Conventional Silicone	Hi-Ten Silicone
Durometer (Shore A)	50	50
Tensile (psi)	950	1400
Elongation (%)	300	500
Tear (lb/in)	80	180
Stiffening Temp. (°F)	-60	-166
Brittle Point (°F)	-100	-175
Comp. Set (22 hr. @ 300 F)	24	25

Fig. 15—Comparison of properties of high-tensile silicone with conventional silicone.

Low Temperature Properties: Typical urethanes stiffen as the temperature is reduced, but show little tendency to crystallize. Although rather stiff at subzero temperatures, urethane does not become brittle down to -80 F.

Resiliency: Urethane resiliency usually falls in the range from 50% to a maximum of 80%, which in general is higher than that of butyl but lower than that of most of the other conventional elastomers.

Oil Resistance: Urethane's oil resistance in mineral oils is better than neoprene but inferior to Buna-N, provided temperatures do not exceed 200 F. Urethane rubber gradually deteriorates in 250 F mineral oil and is completely unserviceable at 300 F. Urethane is not recommended for use with most synthetic hydraulic fluids, hot water, or steam.

The high modulus and high elongation of urethane, together with appropriate hysteresis, provide excellent energy absorbing power and vibration dampening properties. As a mallet head, it is hard enough to drive a ten-penny nail into a solid oak beam without damage to itself. Industrially it is finding wide usage as shock absorber pads in and under heavy machinery, as air hammer handles to absorb shock, suspension bearings on heavy equipment, and flexible couplings. Its strength and flexibility permit it to transmit high loads with high misalignment.

Its abrasion and tear resistance early suggested

urethane's use as a tire material. Hard rubber tires are now commercial and automotive tires are experimental. This material may produce the awaited 100,000 mile tire.

Where temperatures are not excessive, urethane makes a good oil seal. But in today's engines and transmissions, urethane is not being used because of the temperatures encountered.

Extremely hard urethane materials, internally lubricated, are being used abroad as self-lubricating bearing materials and are being evaluated in this country for that purpose.

The urethane rubbers appear to have tremendous potential in the mechanical rubber goods field because of their exceptional physical properties. However, they are not yet used extensively in the automotive industry for such applications, partly because of cost. This material, being so different from conventional elastomers, should not be considered as a direct replacement for currently used materials. To take full advantage of its superior properties, the component must be designed around the material. In highly loaded mechanical rubber parts, far less volume of urethane can be made to do the same job. The resultant savings in rubber volume in many cases would offset the higher cost per pound and give additional bonus features in reduced weight and space requirements. If low temperature stiffening does not prove to be an insurmountable problem, urethane may some day make

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a compact, "super" engine mount. However, converting to urethane in such an application is not an easy step and certainly considerable developmental work would be required.

Urethane is also being considered for use as ball joint liners, gears, and for propeller shaft and universal joint couplings. Urethane also has potential as a coating material on exposed metallic, wooden, and rubber parts, and over flexible urethane-foam upholstery.

Nitrile rubbers

Buna-N, the most common nitrile rubber, is a copolymer produced from building blocks of butadiene and acrylonitrile (Fig. 10).

Butadiene and acrylonitrile can be polymerized in various mole ratios. The higher the acrylonitrile content, the greater the resistance to petroleum oils, fuels, solvents, and heat. The higher the butadiene content, the greater the resiliency and low temperature flexibility. Buna-N polymers, therefore, can be "tailor-made" for specific end uses.

Buna-N withstands dry heat up to about 250 F and most petroleum-based oils up to about 300 F. Abrasion resistance is good. Compression set properties are excellent. Properly compounded, it has no difficulty in meeting a -40 F cold flex test. These properties are responsible for its extremely wide usage in engines, automatic transmissions, and power steering devices, as reciprocating and rotating shaft seals, gaskets, tubing, coated fabric diaphragms, and such.

For dynamically functioning rubber parts, Buna-N does not have the flex resistance of neoprene or the general purpose elastomers. Ester-type hydraulic fluids, extreme-pressure lubricants, and other sulfur-bearing fluids severely degrade Buna-N, particularly at temperatures of 250 F or above. Some of these deficiencies of Buna-N led to the development of polymer modifications and blends as follows:

Carboxylated Buna-N

This polymer is a medium high acrylonitrile copolymer which has been modified to include carboxylic groups in the polymer chain (Fig. 11). The carboxylic group imparts desirable properties to the material, such as: outstanding abrasion resistance, better retention of physical properties at elevated temperatures, and somewhat improved ozone resistance. The abrasion resistance of carboxylated Buna-N is three to six times as great as that of conventional Buna-N. Ozone resistance is significantly improved, but not of the order of that obtained with neoprene or butyl, unless compounded with waxes

for ozone protection. Immersion in oil further improves ozone resistance. Resistance to the aging effects of dry heat and oils is not materially altered.

Improved abrasion and ozone resistance over conventional Buna-N makes the carboxylated nitrile rubber appear promising as fuel and oil line material. In conventional Buna-N, a degree of oil resistance must be sacrificed in compounding to obtain improved ozone resistance. There may be also a slight advantage of this material over conventional Buna-N as o-ring and lip-seal material and it may extend somewhat the use of the nitrile-type polymer in automatic transmissions. Carboxylated Buna-N currently is being evaluated for such possibilities. Straight Buna-N today is borderline in a number of sealing locations.

NBR-Vinyl Blends

These materials are blends of existing polymers—namely, nitrile butadiene rubber (Buna-N) and polyvinylchloride. The Buna-N and vinyl are prefluxed during manufacture in ratios of about 70 parts Buna-N to 30 parts vinyl. The vinyl imparts to the vulcanizate two desirable properties deficient in Buna-N; namely, ozone resistance and flame resistance. The result is a material possessing much of the oil resistance of Buna-N, much of the ozone and weathering resistance of vinyl, and a fair degree of flame resistance. However, NBR-Vinyl compounds still support combustion unless compounded specifically for flame resistance. The flame resistance of regular Buna-N cannot be significantly improved in such manner. Additional "plus" qualities are unusually high abrasion resistance, extrudability, and colorability. On the debit side is reduced heat resistance and compression set properties at high temperatures due to the thermoplastic nature of the vinyl.

Test data show NBR-Vinyl to resist high-swell mineral oils very well. Immersion for 70 hr in ASTM Oil No. 3 at 250 F results in less than 5% swell with retention of 70% of its elongation and 90% of its tensile. Although no data are available on its properties at 250 F or above, strength and tear resistance are expected to be low due to the thermoplasticity of the vinyl in the blend. It cannot be recommended for temperatures in excess of 250 F, and in this respect loses out to straight Buna-N as a seal material in many automobile locations.

Immersion for 70 hr in ASTM Fuel B at room temperature results in about 15% swell with retention of 85% of its elongation and 65% of its tensile. This is comparable to the performance of a good, conventional Buna-N compound. The fuel resistance, coupled with ozone resistance and toughness, suggests its use as a fuel line material.

NBR-Vinyl, properly compounded, does not crack on an accelerated ozone test after two weeks exposure to an ozone concentration of 50 pphm of air. Some compounds are reported not to crack after two weeks in an ozone concentration of 600 pphm of air. In general, the ozone resistance of NBR-Vinyl is considered comparable to that of neoprene.

It is particularly suitable for extrusions, giving very smooth, shiny surfaces.

Its high gum strength (2500 psi) eliminates the

need for carbon black reinforcement to obtain respectable strengths and makes possible the production of a wide variety of bright, stable colors. Its combined weatherability and colorability indicate potential as exposed material for sealing, wire covering, and such where appearance is important. A typical, high grade, colored extrusion compound may have a tensile of over 2800 psi and elongation of over 450%, indicating that toughness also is available in this material. As a colored weather-strip material, it is expected to be superior to vinyl in performance and at a price competitive with that of vinyl.

This material is available under the names of Paracril OZO and Hycar Polyblend (Hycar 1203).

Polyacrylic rubber

The most widely used polyacrylic rubber, commonly referred to as PA rubber, is a copolymer of 95% ethylacrylate and 5% 2-chloroethylvinyl ether (Fig. 12).

PA rubber is a heat and oil resisting material. It is significantly superior to Buna-N in its resistance to heat and hot oil environments, and is successfully used as a seal material in mechanisms such as automatic transmissions in various hot-spot locations.

PA withstands continuous exposure to dry air temperatures of 300 F with little change in its elastomeric properties (Fig. 13). Buna-N embrittles under this condition. The upper limit of dry air temperature for continuous exposure of PA is reported at 350 F, but at this temperature, tensile and elongation changes are significant, about 85% and 50% respectively after one week exposure. However, the material will withstand intermittent exposure to temperatures of 400 F or above and still retain elastomeric properties.

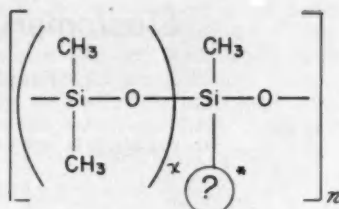
PA is very resistant to mineral oils as indicated by the fact that little change occurs in high-swelling ASTM Oil No. 3 after one week at 350 F.

In ASTM Oil No. 4 (92% ASTM No. 1 and 8% Parapoid 10-C, chosen by ASTM to be representative of extreme pressure lubricants), PA rubber appears to be satisfactory at temperatures up to at least 300 F. Actual operating temperatures where EP lubes are used are usually considerably lower than 300 F, and at the lower temperatures PA rubber is highly satisfactory. Buna-N embrittles in EP lubricants at elevated temperatures due to the presence of sulfur and its vulcanizing effect upon the polymer.

The resistance of PA rubber to aromatic fuels may be rated as good, but lower than that of Buna-N.

PA rubber not only resists the effects of air and most fluids at temperatures of 300 to 325 F, but also retains unusually high strengths at the elevated temperature. This important feature helps to explain the success of PA as a seal material in high temperature service.

Low temperature properties of PA are bad. The brittle point, as measured by a standard ASTM impact-type test, is -5 to -10 F. Fortunately for PA rubber, the laboratory test in this case does a bad job of predicting service performance and PA continues to seal satisfactorily at temperatures down to -40 F. Apparently PA can flex sufficiently to



* Fluorinated side chain.

(Details not revealed)

Fig. 16—Fluoro-silicone is a fluorine-containing silicone. The fluorine addition to the organo-metallic elastomer greatly improves the resistance of the polymer to fluids, particularly the nonpolar types.

FLUID	IMMERSION		Durometer Change	% Volume Change
	Days	Temp		
Iso-Octane	7	75 F	-5	+15
Ethyl Alcohol	7	75 F	-2	+5
ASTM # 3 Oil	3	300F	-6	+4
ASTM # 3 Oil	3	400F	-14	+5
Skydrol 500	3	212 F	-26	+28
Diester Lub. (Mil-O-7808)	3	350F	-19	+10
" " " " "	3	400F	DETERIORATED	
ASTM Fuel "B"	3	75 F	-6	+20
" " "	3	158 F	-6	+18

Fig. 17—Chemical resistance of fluorinated silicone.

withstand, without cracking, the rather small deformations imposed by shaft eccentricity and run-out, and the heat generated rapidly elevates the temperature of the sealing lip to the point where the PA regains its true, elastomeric properties. In applications requiring considerable, sudden flexure of the component at subzero temperatures, as in boots and diaphragms, PA rubber cannot be used.

It is predicted that PA rubber gradually will replace more and more Buna-N as automotive operating temperatures continue to rise.

Silicone rubbers

Silicone rubber is well known for its resistance to high and low extremes of temperature. Conventional silicone elastomers can be made flexible at -130 F and operative at temperatures up to 500 F. Silicone has very good compression set properties at high temperatures and low coefficient of friction against metals. It also is completely ozone resistant and has good electrical properties. These properties account for its present automotive use as spark plug boots and rotating shaft seals in automatic transmissions. These two products, so far, are the only large-volume uses adopted by the automotive industry. Deterents to more widespread usage are high cost, low tensile and tear strengths, rather poor abrasion resistance, and deficiencies in mineral oil and fuel resistance at high temperatures.

Recent developments in silicone materials in-

Elastomers

... continued

Fig. 18—Nitrile silicone rubber consists of a regular silicone polymer with a nitrile radical periodically replacing a H atom of a methyl group.

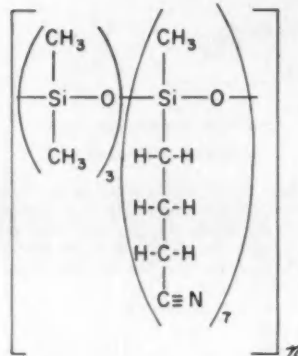


Fig. 19—Fluorinated hydrocarbon is a copolymer of vinylidene fluoride and hexafluoropropylene.



TEMPERATURE LIFE

400° F	2400 Hours
450° F	1000 Hours
500° F	250 Hours
550° F	72 Hours
600° F	24 Hours

Fig. 20—Service life of fluoro-hydrocarbon at high temperatures; time to brittleness.

	ORIGINAL	% RETAINED
Tensile	2650	80
Elongation	180	70
Hardness	71	+ 7 Points

Fig. 21—Effect on fluoro-hydrocarbon of air aging; 28 days at 450 F.

% Volume Change	+ 4
% Tensile Retained	95
% Elongation Retained	100
Hardness Points Change	-1

Fig. 22—Effect on fluoro-hydrocarbon of oil aging in ASTM No. 3 oil; 1 week at 300 F.

clude: high tensile silicone, fluorinated silicone, nitrile silicone, and RTV silicones.

High-Tensile Silicone

High-tensile silicone is a dimethyl siloxane polymer with some methyl groups replaced with phenyl and vinyl groups (Fig. 14).

This material was developed primarily to overcome deficiencies in strength and to retain strength at high temperatures.

Improvements in physical properties of a typical compound over a conventional, general-purpose silicone are shown in Fig. 15.

Resistance to mineral oils is about the same as regular silicone. Both swell considerably, 50% or more, when immersed in ASTM Oil No. 3 at 300 F for one week. Neither is considered resistant to fuels, particularly aromatic types.

There appears to be a discrepancy between the rather poor resistance of silicone to hot mineral oils and its success as an elastomer for a front pump seal in an automatic transmission. This may be explained in part as follows: In this application silicone is used as a lip seal backed up by a garter spring. Silicone is exceptionally heat resistant so that the high temperature developed at the sealing surface does not in itself deteriorate the polymer. The mineral oil and ATF additives swell the silicone considerably, causing softening of the polymer. But this softening does not adversely affect its sealing properties. With correct lip seal design, the backing spring applies just the right amount of pressure between the silicone sealing surface and the metal surface to effect sealing. Buna-N, on the other hand, tends to harden with heat and tends to swell only slightly or even shrink due to the action of the fluid. The net result, under severe operating conditions, is embrittlement with consequent much-reduced sealing qualities.

Silicone has not been applied to o-ring or lathe-cut type seals because of its relatively low tensile strength, tear strength, and abrasion resistance. Perhaps the tougher, high tensile silicone will prove more suitable for such applications. Commercially it is identified as Silastic-916.

Fluorinated Silicone

Fluorine addition to the organo-metallic elastomer affects it in much the same manner as it does the hydrocarbon elastomer—it greatly improves the resistance of the polymer to fluids, particularly the nonpolar types. Fluoro-silicone is such a fluorine-containing silicone (Fig. 16). The fluorine adds fluid resistance to the polymer without materially sacrificing the other desirable properties of silicone rubber. This fluoro-silicone rubber is exceptionally resistant to swelling in mineral oils, solvents, and all types of fuels. In Fig. 17 are some immersion data showing its resistance to some fluids which may be of particular interest to automotive engineers. To make one direct comparison with conventional silicone, the fluorinated material swells 20% in ASTM Fuel B, whereas conventional silicone swells over 200%. Note from Fig. 17 that about the only possible automotive fluids that significantly deteriorate fluorine silicone are the highly polar hydraulic fluids and lubricants. In these fluids the material softens and swells rather than embrittles.

Tensile strength and abrasion resistance of the

fluorinated silicone are comparable to conventional silicone and still appreciably lower than most conventional organic and fluorinated hydrocarbon-type elastomers.

The exceptional oil and fuel resistance of fluorinated silicone, coupled with its extremely good high and low temperature properties, has resulted in early, wide usage by aircraft companies. In the future it should find use also by automotive companies when the price is reduced or when requirements for heat and oil resistance demand the use of such a premium priced polymer. This material is commonly known as Silastic LS-53.

RTV Silicones

RTV (room temperature vulcanizates) silicone compounds are hydroxyl-containing silicone fluids which, with the addition of an organo-metallic catalyst, set up to a tough rubbery solid with properties somewhat comparable to conventional silicone elastomers. They are solvent-free. A number of raw compounds and catalysts are available with curing times ranging from 10 min to 24 hr.

It is difficult to visualize the use, at this time, of RTV silicones for large volume automotive production, but they do appear to have interesting applications as follows:

1. Encapsulating and potting electrical items.
2. Making molds for duplication of small parts.
3. Making trial parts for prototypes and models
4. Caulking, sealing, and patching.

Nitrile Silicone Rubber

The newest of the silicone rubbers to be introduced is NSR (nitrile silicone rubber). Structurally, NSR consists of a regular silicone polymer with a nitrile radical ($-\text{C}\equiv\text{N}$) periodically replacing a H atom of a methyl group (Fig. 18.) Polarizing the silicone molecule with the nitrile groups makes the polymer more resistant to nonpolar fluids such as gasoline and naptha. The properties of the nitrile silicone are determined by the repeat frequency of the nitrile side chain and its distance from the silicon atom. The specific polymer available today, in experimental quantities only, may be identified chemically as methyl-B-cyanoethyl dimethyl-siloxane, as shown in Fig. 18. It might be said, in a general way, that NSR gives the oil resistance of a nitrile rubber like Buna-N and the temperature resistance of a silicone, a very desirable combination that overcomes a major deficiency of conventional silicones.

Performance data on NSR are limited at this time. NSR currently is being evaluated by rubber companies and end users. Laboratory immersion data indicate marked superiority over conventional silicone in its resistance to fuels and oils. But like most of the other silicones, the nitrile silicone is somewhat deficient in tensile and tear properties.

NSR currently is being aimed principally at aircraft applications and oil seals for automatic transmissions.

Fluoro-elastomers

The family of fluoro-elastomers is noted for exceptional resistance to fluids at high temperatures. Before the introduction of the fluorinated materials,

silicone stood alone as a usable elastomer for temperatures of 400 to 500 F. The silicones could withstand the temperatures but were deficient in resistance to many fluids — mineral oils and gasolines, particularly the aromatic type. The fluoro-elastomers combine good fluid resistance with good thermal stability.

Fluorinated Hydrocarbon

This particular type of fluorinated hydrocarbon is a copolymer of vinylidene fluoride and hexafluoropropylene (Fig. 19).

Its excellent heat resistance is shown in Fig. 20, which indicates the approximate service life (time to brittleness) at various high temperatures.

Another indication of its retention of physical properties after exposure to elevated temperatures is shown by the data obtained on a typical compound. (Fig. 21). Temperatures in the neighborhood of 300 F have no significant effect on it.

Fluoro-hydrocarbon's extreme resistance to high-swell type mineral oils is shown by physical-property changes after aging for one week in ASTM No. 3 at a realistic automotive operating temperature of 300 F (Fig. 22).

This elastomer is practically unaffected by ozone, oxygen, and weathering. Exposure under stress for 400 hr to the abnormal ozone concentration of 10,000 pphm causes no cracking. By way of comparison, an ozone resistant SBR material for weatherstrips is considered satisfactory if it exhibits minute cracks after 70 hr in an ozone concentration of 50 pphm.

Low temperature properties are moderately good. Although the material stiffens rapidly at subzero temperatures, brittleness is not reached above -40 F, the critical temperature for most automotive applications.

In comparison with conventional elastomers, it exhibits very low compression set at elevated temperatures.

This copolymer has demonstrated excellent resistance to both transmission and rear axle EP oils, and to combination rear axle and transmission oils. Specimens immersed for 7 days at 350 F swell, in all cases, less than 5%. Tensile strength and extensibility are 80 to 100% retained. Hardness is virtually unaffected.

It currently is used as a valve-stem seal for a popular super-duty truck engine as a guarantee against trouble in that location.

It is practically unaffected by gasoline — even fuels that are better than 50% aromatics; Rubber parts for fuel and gasoline pumps are a natural for this material. Carburetor cups and seals currently are being made from it.

This fluorinated material has outstanding resistance to silicate esters, is less resistant to phosphate esters, and is not considered satisfactory for highly polar fluids or for organic acids, ketones, aldehydes.

Fluorinated materials have the wherewithal to handle tough automotive diaphragm and sealing problems as future requirements become increasingly severe.

Typical of these materials are Viton and Fluorel.

To Order Paper No. 82U . . .

. . . on which this article is based, turn to page 6.

pros and cons of different Aluminum Engine Cylinders

Producibility is the key to the method that will predominate in the American market.

Based on paper by

A. F. Bauer

Doehler-Jarvis Division, National Lead Co.

COMPETING for the job of producing wear-resistant aluminum cylinder barrels are four production techniques. They are: wet steel sleeves, transplant coating for sleeves as well as engine block bores, cast-in sleeves, and high-wear aluminum alloys. All of these techniques make use of the economical die casting method of producing engines — and the choice between them will also depend on the economy of production consistent with good reliability.

Wet sleeves

Wet sleeves can be made of iron, aluminum with a high-wear surface, or a high wear (hypereutectic) aluminum.

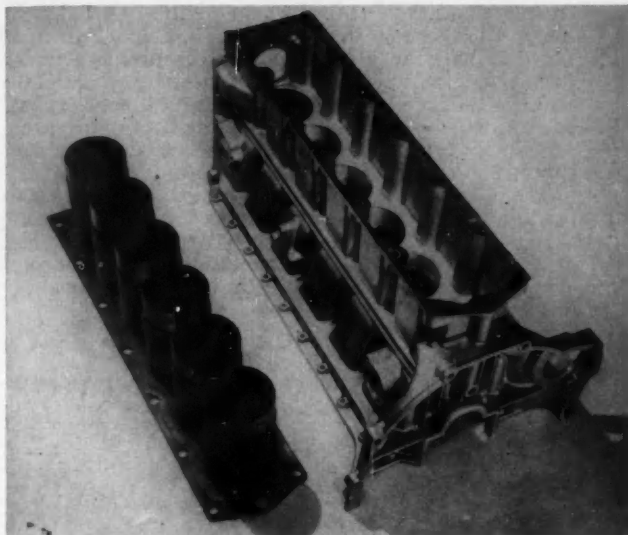
Cast-iron sleeves are usually used in conjunction with a steel deck plate. This results in some expansion problems and gives rise to galvanic corrosion. The cost of producing this combination is high, and machining of the engine blocks is interrupted by assembly of sleeves. However, the oil retention for cold starts is good with cast iron and its wear properties are well known.

A better solution is to use wet sleeves in aluminum. Here, there is no expansion or corrosion problem and the advantages of lighter weight and better

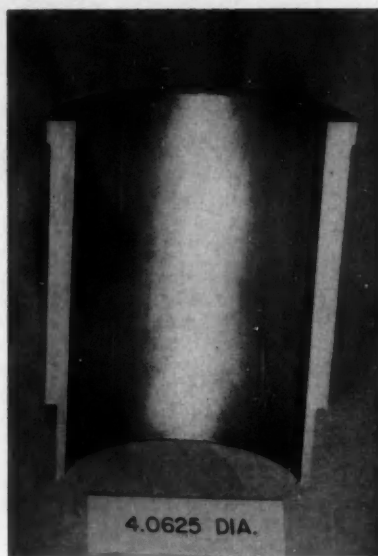
thermal conductivity are realized. But the bore of the sleeve must be protected against excessive wear. Two methods are already in use; porous chrome plate and sprayed molybdenum-iron coats. The chrome-plate method is already used in some European cars. The major disadvantage of these methods is cost. A third, relatively new method is the use of a transplant coating.

Transplant coatings are made by depositing metal on the core of the die that produces the cylinder bore. The injected aluminum then shrinks onto the rough outside of the sprayed coat. Because of differential expansion, the steel coat stays with the aluminum die casting and creates a taper-free bore of extremely high smoothness (30 rms) and a high accuracy (± 0.003). Only a slight honing operation is needed to finish the bore. The coating can be made of almost any material in any thickness and porosity.

Hypereutectic alloys of aluminum are now confined to the production of pistons. Although theoretically a good wear material, there remains the problem of a cold start. The alloy does not have the same capacity to retain oil as gray cast iron, and the cold start problem does not show up in the laboratory tests conducted under ideal conditions. Production problems also include a 20–30% decrease in die life (depending on whether permanent or injection molds are used) due to the 200 F increase in casting temperature needed over standard casting alloys. Design-wise, the low elongation makes parts quite brittle — though this is compensated for by the wear characteristics of the alloy. But machining speeds and tool life cause increased costs when this alloy is processed, because of this same

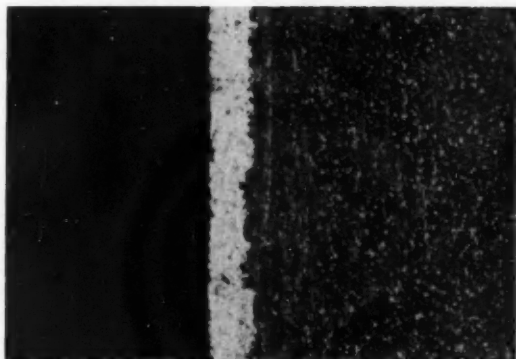


A DIRECT APPROACH is to weld gray cast barrels to a steel plate.

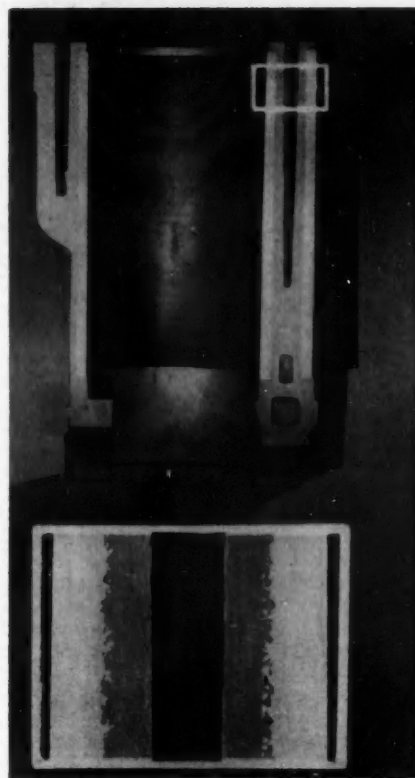


WET SLEEVES can also be made from aluminum with wear resistant coatings—in this case a transplant coating.

Cylinders for Aluminum Engines . . . which one will win?



TRANSPLANT COATINGS can give an economical wear surface to wet or dry aluminum cylinders.



CAST-IN DRY SLEEVES are one solution for aluminum engines. In the example, there is an intimate bimetalllic interlocking bond, which results from an initial rough OD of the sleeve and the high die-casting pressure penetrating the sleeve.

Aluminum Engine Cylinders

... continued

hardness. On the positive side is the low thermal expansion, which decreases from 11.5 to 9.2 as the Si content increases. See Table 1.

Dry sleeves

Dry sleeves are usually cast or pressed into the bore of an engine. The casting process is good if a bond can be formed between the sleeve and the block. Normal casting procedures may produce

shrinkage away from the sleeve in the heavier sections, this results in voids and hot spots in the sleeves. One way to overcome this problem is to form a mechanical locking bond between the sleeve and the block. This is done by using a centrifugal casting for the sleeve and retaining its rough outer surface. Die cast aluminum is then forced into the spine-like openings in the cast iron, forming an interlocking surface. Shear strengths up to 18,000 psi are produced as compared to the 6000 psi experienced with plain sleeves. There is no evidence of separation with this bimetallic interlock bond even at temperatures close to the melting point, tests at Doehler-Jarvis show.

To Order Paper No. S201...

... on which this article is based, turn to page 6.

Table 1 — Physical Data on Hypereutectic Al-Si Alloys in Comparison to Standard Al-Alloys and Gray Iron

Class of Alloy	U.S. Data Die Casting		European Data on Permanent Mold Pistons			Gray Iron
	Eutectic		Hypereutectic			
	Aluminum	Aluminum	Aluminum	Aluminum	Aluminum	
Basic Materials	12% Si	12% Si	18% Si	21% Si	24% Si	Iron
Main Additions	None	1% Cu, 1% Ni, 1% Mg	1% Cu, 1% Ni, 1% Mg			SAE 120
Secondary Additions						
Thermal Expansion, in./in./F x 10 ⁻⁶	11.5	11.4	10.3	9.7	9.2	6.1
Thermal Conductivity, cal/cm/sec/C	0.29	0.31	0.28	0.27	0.25	0.12
Brinell Hardness, kg/mm ²						
At 68 F	80-110	90-125	90-140	90-120	90-125	200
At 300 F		75- 95	80-110	80-105	70-105	200
At 480 F		35- 50	40- 70	50- 70	45- 65	170
Ultimate Tensile Strength, psi						35,000
At 68 F	39,000	31,000	29,000	28,500	28,500	
At 300 F	27,000	25,500	24,000	24,000	23,500	
At 480 F	14,500	14,200	15,000	15,000	15,000	29,000
Elongation, %			0.2-0.8	0.2-0.5	0.1-0.3	0.9
At 68 F	0.8-1.5	0.3-1.0	1.3-2.3	1.2-2.1	1.0-1.8	
At 480 F	3.0-5.0	3.0-5.0				
Modulus of Elasticity, psi x 10 ⁻⁶	10.3	10.7	11.4	12.3	12.3	15.0
Relative Abrasion Value	1.0	1.0	0.9	0.8	0.7	0.4
Casting Temperature, F	1250	1300	1400-1430	1480-1520	1570-1610	
Reduction of Mold Life Compared to Eutectic Al-Si Alloys			10%	15%	20%	
Increase in Cutting Tool Wear Compared to Eutectic Al-Si Alloys			Twice	3 times	4 times	

PROPERTIES OF BIS (META-PHENOXY PHENYL) ETHER



LUBRICITY	EXCELLENT
TOXICITY	NONE
SPONTANEOUS IGNITION POINT	1095°F
MAXIMUM ACID NUMBER CHANGE	0.2 mg/g
POUR POINT	+15°F
RADIATION RESISTANCE	WITHSTANDS 1 TO 5×10^6 erg/g C AT 800°F

BREAKTHROUGH - -

1000 F Hydraulic Fluid

Space re-entry vehicles could use a hydraulic system based on a polyphenyl ether fluid.

Based on a report by

William E. Mayhew

Republic Aviation Corp.,
(To SAE Committee A-6, Aircraft & Missile Hydraulic & Pneumatic Systems & Equipment)

A POLYPHENYL ETHER fluid will operate up to five hours at 1000 F and still be usable in a space vehicle hydraulic system, tests by Republic Aviation show. This breakthrough will accelerate the development of other components, such as seals and pumps, and promises to provide an operational 1000 F hydraulic system in the near future.

The actual fluid is bis(meta-phenoxy phenyl) ether. Some of its physical properties are shown in the illustration. The fact that the fluid can withstand the combined effects of high temperature and radiation makes it a natural for nuclear-powered vehicles.

The 1000 F tests were conducted with a simple miniaturized (one pint) hydraulic system, which

contained four basic parts: a pump, a check valve, an orifice, and a reservoir. The pump was maintained at 1000 F and the reservoir at 700 F. Pressure is varied by changing the speed of the pump or the size of the orifice. With these conditions, the fluid was still usable after five hours.

During all the test at 1000 F and lower temperatures, no matter what the degree of degradation of the fluid, only a small change in acidity was noted. Further evidence of the stability of the fluid is the welcomed slight increase in viscosity. During all the tests, there was no insoluble matter formed that might plug orifices.

Similar tests were run at 900 F. However, the whole system, including the reservoir, was maintained at 900 F. Under this condition the fluid was usable up to a maximum of five hours.

An analysis of the fluid after the tests gave the following results:

	Before Test	900 F, 5 Hr	1000 F*, 5 Hr
Acid Number, mg KOH/g	0.046	0.018	0.037
Viscosity, cs	2.57	4.76	2.92
Insolubles	None	Neg.	Neg.
Fluid Condition	—	Poor	Reusable

* Reservoir temperature maintained at 700 F.

Grumman Plans Hydrofoil Seacraft

Study shows feasibility, increased productivity, and design possibilities. Long-range craft will be nuclear-powered.

Based on talk by

Donald Lowman,

Grumman Aircraft Engineering Corp.
(Before SAE Aircraft Activity Committee)

GRUMMAN Aircraft and its affiliate, Dynamic Developments, Inc., have studied the feasibility and design of hydrofoil seacraft for fast passenger and cargo transport. They found that such craft can carry payloads 10-60% of their gross weight, operate at greater speeds than fast displacement vessels, and have acceptable passenger comfort in rough seas.

In fact, they will have an 80-ton vehicle ready for

test in mid-1960; are also designing a chemically fueled prototype craft; and plan to start a nuclear hydrofoil boat by 1966.

The design and construction of hydrofoil craft must follow aircraft techniques because high strength-weight ratios are required.

Design parameters studied include speed (50-200 knots), displacement (100-3000 tons), range (400-3600 miles), foil, powerplant, and propeller.

What kinds of hydrofoils?

Two basic types of hydrofoil cross-sections — subcavitating and supercavitating — were extensively investigated. Best performance resulted from using subcavitating sections at low speeds (below 70 knots), and supercavitating sections at higher speeds.

Briefly, here's how these two sections function. . . . The supercavitating sections depend on lower surface pressures for operation. A steady-state cavity of air and water vapor is formed above their upper surface. The upper boundary of this cavity is a constant-pressure streamline, above which smooth flow exists (Fig. 1).

Subcavitating section water flow is similar to the airflow about a conventional aircraft wing section. At high speeds a transient cavity may also form over these sections. But — its instability causes a rapid drag rise, erosion of the upper surface, and loss of lift.

Hydrofoil area distribution was also studied. . . . Conventional longitudinal area distribution was found best for subcavitating operations, while choice of distribution is less important for supercavitating operation.

With either sub- or supercavitating sections, a split lateral area distribution is best for stability and improved lift-drag ratios.

As to submerged versus surface-piercing foils — both sub- and supercavitating sections showed higher lift-drag ratios in the flat, fully submerged

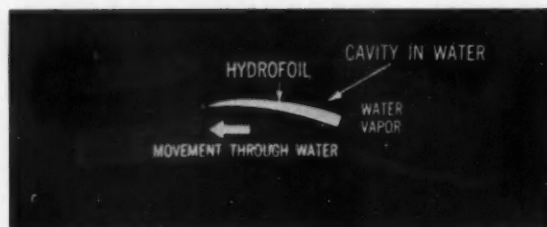
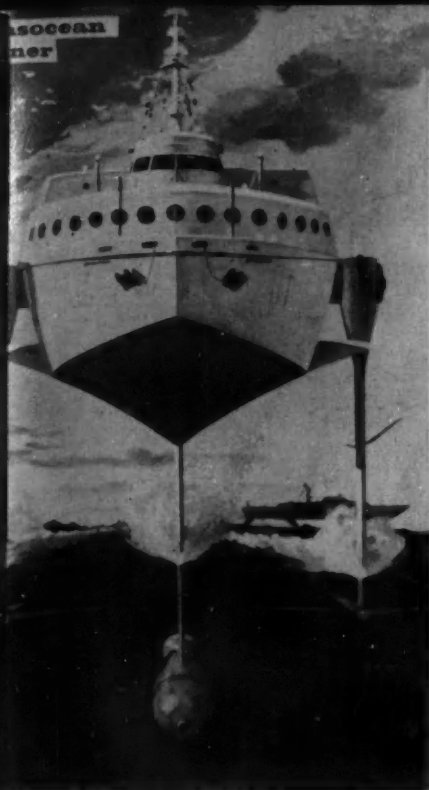


Fig. 1 — Supercavitating hydrofoil.

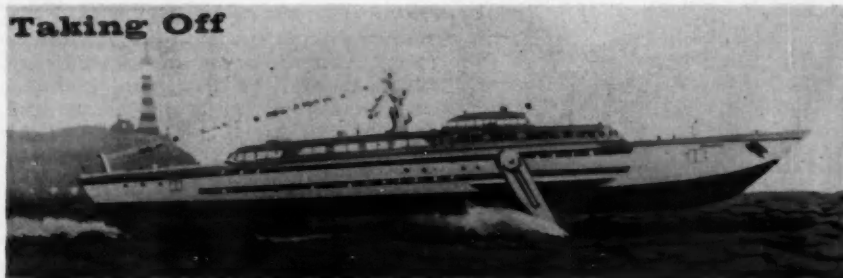


Nuclear-powered craft

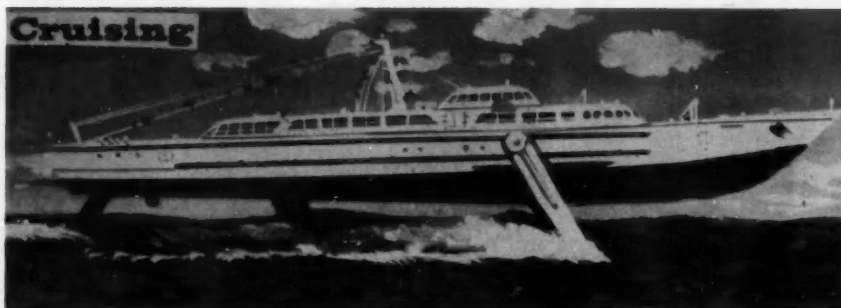


... departs under auxiliary power, with foils retracted.

Taking Off



Nuclear engine starts in open water, and the foils go down.



Foils are completely down at full speed.

Grumman Plans Hydrofoil Seacraft

... continued

kind. (But only surface-piercing configurations can be made inherently stable).

The number of struts depends on type of foil and speed. Multiple struts were found superior only when used with subcavitating foils at speeds below 65 knots. At higher speeds — and with all supercavitating foils — one strut per foil gave higher lift-drag ratios.

Strut and pod sections match the foil operation — streamline for subcavitating, and parabolic with blunt trailing edges for supercavitating.

The above considerations led to selection of the optimum configuration for either sub- or supercavitating foils. It consists of a conventional arrangement, with fully submerged split main foils — each supported by a single strut. Together they carry 80% of the craft weight; the balance is carried by a single submerged tail foil.

Environment

It was determined by a survey that 90% of the time, wave heights are 20 ft or less in the Atlantic Ocean. So, the 20-foot wave was chosen as the sea state in which the craft should operate while foil-borne without hull wave impact.

Structure design

Basic design considerations were displacement operation, and foil-borne operation with and without wave impact.

It was found that the low-speed displacement condition, applying conventional marine hull loads, was not critical for the structure. The foil-borne condition without wave impact — which is the nor-

mal operating condition — applies the maximum loads to the foils, struts, and attachment structure.

Because the condition of foil-borne operation with hull wave impact resembles a seaplane landing in rough water, Navy seaplane hull design specs were used. This method permits local hull bottom pressure to be determined from consideration of hull speed and bottom shape, the point of impact, and mass effects.

Using these procedures, the hull weight percentage was found to average 15%, decreasing only slightly with increasing gross weight. This figure is consistent with that for seaplane hulls and light-alloy displacement ships.

The best material for the structure is weldable aluminum alloy.

Propulsion — powerplants and propellers

The nuclear powerplant — with relatively high specific weight but negligible fuel consumption — is suitable for hydrofoil craft at extreme ranges. For ranges over 3000 miles, a closed-cycle gas-cooled plant, mounted in an underwater pod, is worthy of development. . . . Such a plant could be available within 10 years.

The gas turbine — while a larger weight fraction than the diesel — provides higher productivity at short ranges.

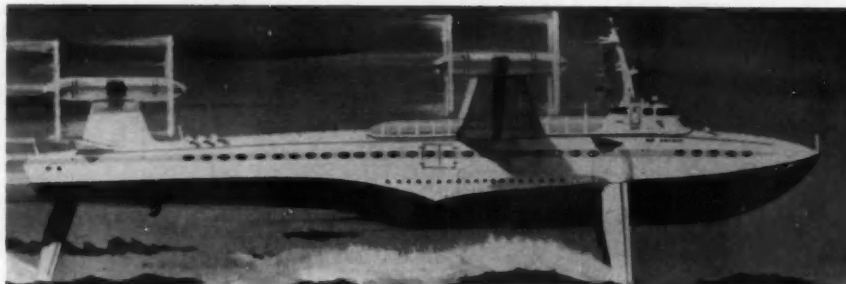
Eliminated from the study were (1) direct jet thrust, because it is too inefficient at the speeds considered, and (2) the steam turbine, since it is heavier and has higher fuel consumption than either the gas turbine or the diesel compound.

Choice of propulsive devices was narrowed to water or air propellers. In most cases, the water propellers were supercavitating because of their superior performance over subcavitating propellers at the craft speed involved. However, air propellers are best suited to high-speed, light-displacement craft.

The study eliminated (1) water jet pumps and nuclear underwater jets due to low efficiency, (2) shrouded underwater propellers because they increase drag out of proportion to any efficiency increase, and (3) shrouded air propellers, because of severe weight penalties and cross-wind operating difficulties.

Weight of water propellers is less than one percent of the craft displacement, while that of air propellers is 5%. The power transmission system to drive an air propeller is approximately 0.30 lb/hp using a gas turbine, or 1.00 lb/hp using a diesel com-

Fig. 2 — Air propellers powered by gas turbines.



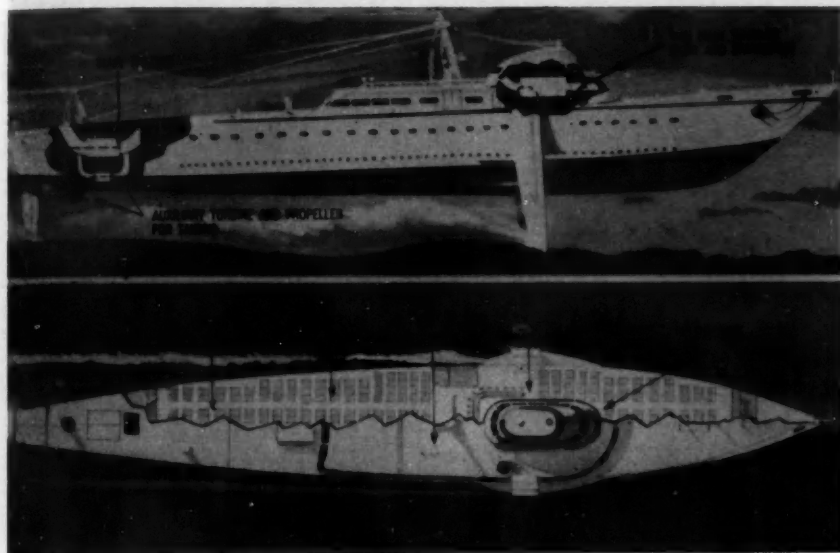
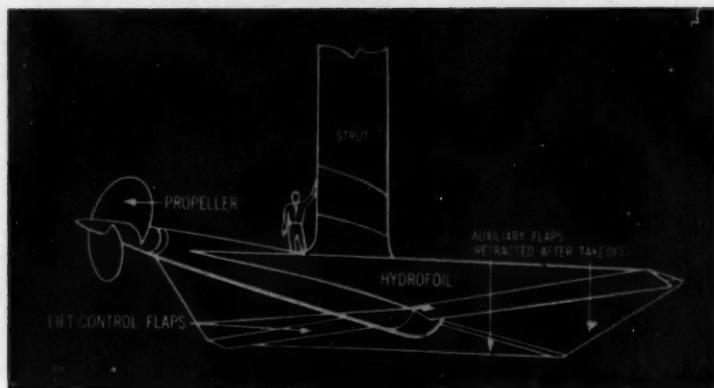


Fig. 3—Water propellers driven by gas turbines.

Fig. 4—Supercavitating foil with supercavitating water propeller. Flaps are auto-pilot-controlled.



pound. Water propeller trains weigh 0.65 lb/hp and 0.70 lb/hp respectively.

Autopilot needed

An autopilot system is needed to limit accelerations and to provide stability. This is because fully submerged foil systems are not inherently stable, and surface piercing systems can produce very high accelerations in a seaway. Such a control system would also assist take-offs, landings, and maneuvers.

Acceptable passenger comfort limits—rather than strength limits or control capabilities—will govern the maximum permissible accelerations. With accelerations limited to a "comfortable" level, only a negligible amount of wave contouring would be permissible. Computer studies of a longitudinal control autopilot showed that accelerations in a seaway can be reduced to this level while providing adequate craft stability and maneuverability. Such a system—with fail-safe characteristics—is now being designed.

Design studies

Based on this parametric analysis, design studies of several hydrofoil craft were made.

- For a range of 1200 nautical miles and 100-knot speed, the optimum craft has a gross weight of 500 tons, uses supercavitating foils, and is powered by gas turbines and driving air propellers (Fig. 2).

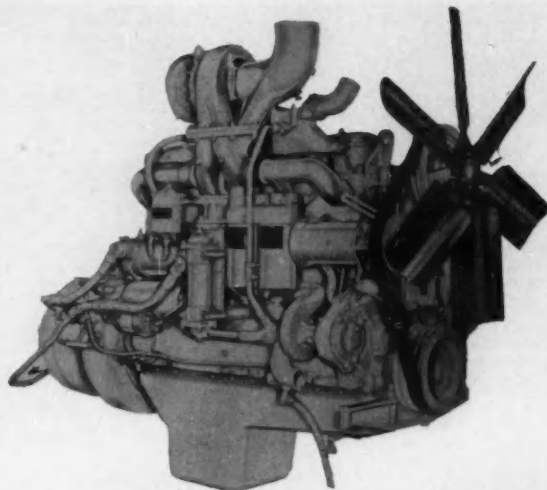
- A craft of the same gross weight was designed to perform the same mission using water propellers. This craft is similar in size, also uses supercavitating foils, but requires more gas turbine power (Figs. 3 and 4).

- To explore nuclear-powered craft, an optimum 1000-ton craft was designed. It has subcavitating hydrofoils, and an over 50,000-hp pod-mounted powerplant driving one water propeller. Cruise speed is 65 knots.

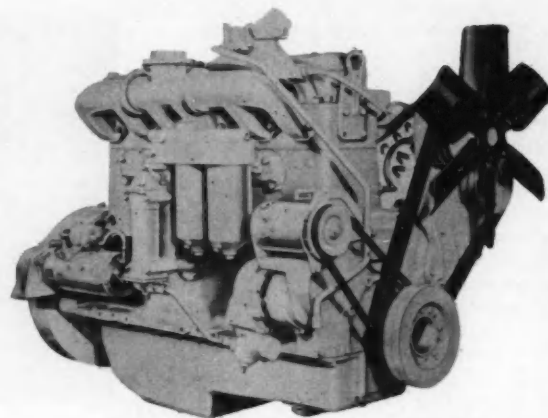
Each of these craft uses retractable hydrofoil systems—the strut is retracted by simple single-axis rotation.

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How Allis-Chalmers chose a Combustion System for New Diesels



Turbocharged diesel—the 21000.



Naturally aspirated diesel—the 16000.

Based on paper by **Hans L. Wittek**

Allis-Chalmers Manufacturing Co.

ALLIS-CHALMERS SOLVED some basic combustion problems in original fashion when it designed the new direct injection diesel engines. Features of the 16000 (naturally aspirated) and 21000 (turbocharged) include:

- Open, small-diameter combustion chambers.
- Four relatively large nozzle holes.
- Masked valves.
- Low valve overlap.

Performance data show that the system results in low fuel consumption.

Nozzle holes

Nozzle holes with a 0.012-in. minimum diameter

were specified, because this seemed the smallest that could be trusted to the average mechanic. It was increased to 0.0138 in. for the 16000, and 0.0158 for the 21000 during development.

Anticipated fuel quantity per cycle, established hole area, and desirable duration of injection of approximately 25 deg crank angle, showed that four or five nozzle holes were required. The lower number was chosen to obtain the largest possible nozzle hole diameter.

Moving the air to the fuel

The basic combustion chamber design problem is to offer to the fuel, at the right moment, all the air intended for it. So a particle of air near the edge of a circular chamber must cover, during injection, a distance equal to the chamber circumference divided by the number of sprays (Fig. 1).

Basic design considerations of new Allis-Chalmers diesels

THE 16000 and 21000 diesels are intended to power specific crawler and wheel vehicles built by Allis-Chalmers. So the original design and performance specifications were defined by the space available in these machines, and by the power and torque characteristics required by them. Also, the engines had to be suitable not only for commercial applications such as generator sets, shovels, and compressors, but also for oil field and marine service.

Table 1 shows the desired performance requirements. Other necessary characteristics were:

- Stamina needed in construction service.
- Good starting in low temperatures.
- Smoke-free operation.
- Low heat rejection.
- Potentially high specific output.
- Simple, plain, and symmetrical cylinder head.
- Good flexibility and wide speed range without avoidable complications.
- Relatively large injector holes.

With torque and speed requirements established, calculations showed that a 5 1/4-in. bore and 6 1/2-in. stroke would give the desired performance.

To meet the low heat rejection and good starting requirements, an open chamber combustion system had to be used.

Before any actual design work could be started, the number of valves had to be decided on. Experimental work showed that a three-

Table 1 — Performance Requirements

Application	Type	Rated bhp	Power rpm	Peak lb-ft	Torque rpm
HD-16	Crawler	155	1600	552	1200
HD-16C	Crawler	165	1800	524	1200
TS-260	Wheel	220	2000	643	1500
HD-21	Crawler	240	1825	702	1600

valve arrangement — two intake and one exhaust — would result in low pumping losses and reasonable cost. So this arrangement was used.

The article discusses the considerations which led to the final combustion system design. Resulting fuel economy is also demonstrated.

Discussions of the paper upon which this article is based were submitted by B. Loeffler, Mack Trucks, Inc.; K. J. Fleck, Caterpillar Tractor Co.; and L. D. Evans, International Harvester Co. All three commended Allis-Chalmers on the low fuel consumption of the new diesels, and disagreed with the use of masked valves. They were split on the valve timing. Excerpts from the discussion, and the author's reply, follow the article.

This is expressed:

$$\frac{2r_c\pi}{12h} = v_{tc} \times t$$

where:

r_c = Combustion chamber radius, in.

h = Number of spray holes

v_{tc} = Tangential air velocity in the combustion chamber, ft/sec

t = Duration of injection, sec

If nothing is done to increase the tangential air velocity in the combustion chamber after the air has been admitted to the cylinder, then the tangential admission velocity (v_{tv}) has to be at least equal to the required swirl, provided that the mean distance of the entering air stream from the cylinder axis is equal to the radius of the combustion

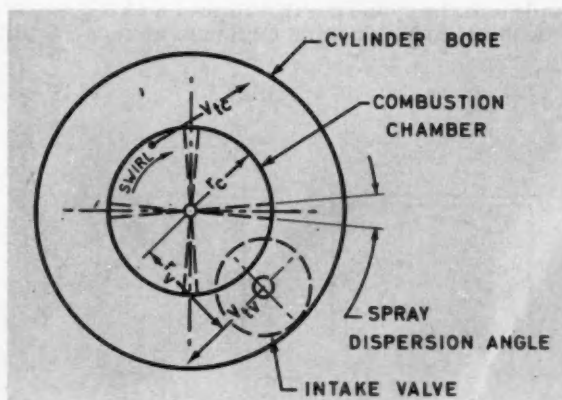


Fig. 1 — Tangential air movement.

Combustion System for New Diesels

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chamber. If this is not so, it could be assumed that the condition

$$v_{te} \times r_c = v_{te} \times r_v$$

would have to be fulfilled so as to produce the needed swirl.

Expressed as a function of engine rpm (N) and angular duration of injection (a),

$$t = \frac{60}{N} \times \frac{a}{360} \quad (1)$$

Thus,

$$\frac{2r\pi}{12h} = v_{te} \times \frac{60}{N} \times \frac{a}{360} \text{ and} \quad (2)$$

$$\frac{r\pi}{6h} = v_{te} \times \frac{r_v}{r_c} \times \frac{60}{N} \times \frac{a}{360}, \quad (3)$$

$$v_{te} = \frac{r\pi}{6h} \times \frac{r_c}{r_v} \times \frac{N}{60} \times \frac{360}{a} \quad (4)$$

If the combustion chamber were a flat disc, having the cylinder bore for its diameter, then, for an engine having 25 deg duration of injection, 5.25 in. bore, 4 injector holes, an inlet valve located 1.75 in. from the axis of the cylinder and operating at 2000 rpm the theoretically necessary tangential inlet velocity would be:

$$V_{te} = \frac{5.25\pi}{2 \times 6 \times 4} \times \frac{5.25}{2 \times 1.75} \times \frac{2000}{60} \times \frac{360}{25} = 248 \text{ ft/sec}$$

This result would be slightly modified by taking into consideration the spray dispersal angle. Assuming it to be 10, V_{te} would become $248 \times 80 = 220$ ft/sec.

The inlet air stream, to fill the cylinder, must obviously have a vertical component in addition to the tangential one. In other words it must slant downwards into the cylinder. If it formed a 45 deg angle with the cylinder axis, the minimum air velocity at

the point of entry into the cylinder would then have to be $220 \times \sqrt{2}$, or 312 ft/sec.

All this was based on minimum required tangential swirl velocity at the time of injection. But it is reasonable to assume that the air will be slowed down substantially during the relatively long time which it spends in the cylinder prior to injection, that is, during the whole of the compression stroke. It is anybody's guess how much this slowing down would amount to but, intentionally underestimating it at about one-third of the initial value, in the example cited, the necessary mean inlet air velocity would be 465 ft/sec.

The foregoing calculation is not only over-simplified but also the assumption of the existence of a forced vortex instead of a free one, which is equally likely to exist, is open to contention. Also the path of a fuel droplet cannot be a straight radial line. It is deflected by the air movement and, as soon as the droplet acquires a rotary motion around the cylinder axis, it becomes subject to centrifugal forces. This is the reason why experimental data on spray penetration, obtained in a quiescent atmosphere, are not of much help if a rapidly rotating vortex exists.

In spite of these reservations, equation (1) agrees quite well with experimental evidence.

An actual air velocity anywhere near the one mentioned would, of course, have a detrimental effect upon volumetric efficiency. So we have to find means to either reduce the required swirl velocity or to increase the swirl after the air has passed through the intake valve, or both.

For a given number of nozzle holes, engine speed and combustion chamber diameter, the necessary swirl velocity increases as the latter parameter. The obvious answer then, is to reduce this diameter.

The benefit derived from doing this is twofold: the required tangential speed is reduced and, thanks to the law of conservation of energy, the angular velocity of the swirl is increased.

Theoretically, this increase should be inversely proportional to the ratio of squares of the two diameters, so that the swirl should increase four times if the diameter of the rotating body of air is halved. In reality, the gain in swirl is not that great, being somewhere near the direct ratio of radii, but it is, nevertheless, very worthwhile. It means that, for any required swirl rate, the needed air velocity at the valve can be reduced by a little more than one-half, if the combustion chamber diameter is about equal to one-half the bore.

As we assume that the compression ratio is fixed, a decrease in the diameter of the combustion chamber requires an increase in its depth. As shown in Fig. 2, the shape of the chamber no longer conforms to that of the spray. If only the primary air movement, the swirl, existed so that the air content of the chamber rotated like a solid disk, we would not achieve our basic objective, namely to pass all air through the fuel sprays while injection takes place. However, the smaller diameter of the chamber, or rather the remaining flat part of the piston crown, quite automatically supplies the needed secondary air movement, the squish.

Theoretical squish velocity is proportional to the difference between the squares of cylinder bore and cavity diameter. Fig. 3 shows the tangential and radial components of the airflow as it enters the cavity.

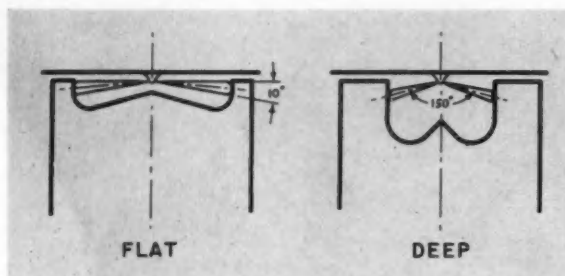


Fig. 2 — Combustion chambers.

Depending on its distance from the nozzle, a fuel droplet is contacted by air travelling across, as well as with, the direction of its own movement. Then, whatever are the conditions conducive to short ignition delay, they will be fulfilled somewhere along the line. Proximity to a wall and the temperature of the latter can also contribute to shortening the delay period. Experiments indicated an unexpectedly short delay.

Chamber shape

The combustion chamber is cylindrical, with straight walls. Although everything which has been said would apply equally well to a spheroidal or ellipsoidal chamber, manufacturing and controlling the size and finish of these cavities is not easy. Allis-Chalmers feels that performance of their combustion chamber is equal to that of the complicated forms.

Fuel should not reach the cylinder wall, and the impingement angle as well as the wall temperature must be exactly right if smoke and objectionable smell are to be avoided. The deep combustion chamber of cylindrical form provides quite a target for any desired impingement without the risk of liquid fuel reaching the cylinder wall. The gradient in wall temperature — highest at the top and lowest at the bottom of the cavity — permits choosing the correct wall temperature at the place of impingement by selecting the spray cone angle. If this angle also works so far as the existing airflow pattern is concerned, the arrangement is most effective. The spray cone angle for these engines — which proved to be "right" — was 150 deg.

The compact chamber design benefits starting ability. The cold cylinder head and piston surfaces are much farther away from the fuel spray than if the wall shape conforms to that of the spray.

The chamber shape permits hot core formation. . . . Core temperature is at least 160 F above the mean compression temperature when the wall temperature is around 30 F and the cranking speed 150 rpm. What is equally important is that the hottest point is located about one-half of the cavity radius outwards from its axis and about one-third of its depth above the bottom. Thus the lower edge of the

spray passes through the area having the highest temperature.

Masked valves produce initial swirl

Masked valves were used to produce satisfactory swirl over the whole speed range. No matter what arrangement is used, the desired swirl is easily produced for one specific engine speed. But retaining satisfactory conditions over the whole speed range is much more difficult. . . . With directional ports or guiding members inserted or cast into the intake port, variable injection timing was necessary to get good behavior over the whole speed range.

Directional control becomes less effective the lower the engine speed when no mask is used because lower velocity through the throat will permit air to enter in an undesirable direction, permitting it to counteract the desired swirl.

This can be compensated for to some extent by retarding injection. But if proper performance over a wide speed range is desired, a choice has to be made between the added complication and high cost of a variable injection timing device or the slightly increased cost of a masked intake valve. The higher

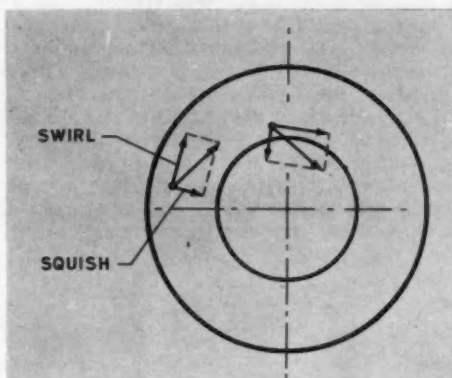


Fig. 3 — Swirl and squish.

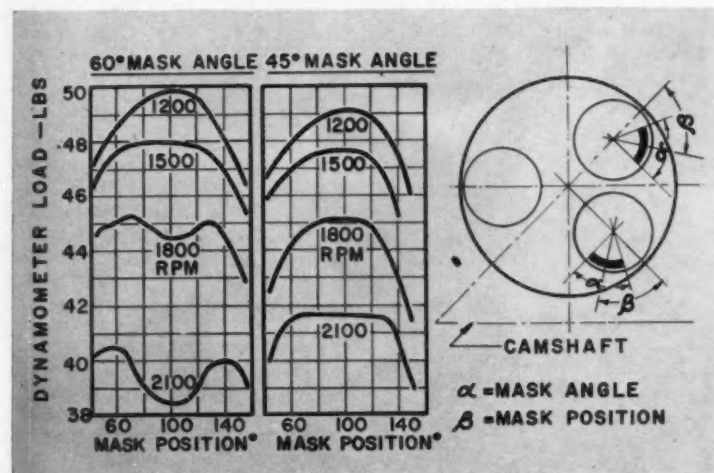


Fig. 4 — Torque versus swirl, fixed rack and fixed timing.

Combustion System for New Diesels

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valve cost is the only drawback of the masked valve. The life of the non-rotating intake valve equals that of the conventional type.

The valve mask keeps its effectiveness during the entire intake cycle, whereas the other methods are bound to become less and less effective the farther the valve is off its seat. And they are least effective at the time when control is most needed — at full valve lift and highest mass flow.

Finding the proper mask angle and mask position — in other words producing the correct initial swirl rate — is the most time-consuming work. The mask angle is the angle contained between the valve radii which pass through the outer corners of the mask. Mask position is the angle between the center line of the mask and a bore radius laid through the axis of the valve.

Fig. 4 shows a pair of typical mask rotation curves for 60- and 45-deg mask angles.

The 45-deg mask angle was chosen. It is a far better match, as the best mask position is the same for all speeds. In addition, performance is quite constant over a wide range of positions. This means that neither unavoidable play in the locating mechanism, nor slight deviations in the shape of the intake ports will adversely affect performance. The 60-deg mask is useless as its optimum positions are different for every engine speed. Furthermore, the 1800 rpm, and particularly, the 2100 rpm torque curves show that over-swirling occurs.

The valves are kept in position by a sliding key milled into the upper part of the valve stem. A valve locator, piloted on the valve guide and fixed in a definite angular position by a locating pin in the cylinder head, permits free axial movement of the valve but maintains the mask position.

Low overlap

Another decision concerned the amount of valve overlap. Usually a large overlap has been considered necessary for supercharged engines for benefits like better scavenging and internal cooling. However, Allis-Chalmers felt that the disadvantages might outweigh the advantages. It seemed possible that the only noticeable benefit would be turbine inlet temperature, but there would be no great benefits in piston and valve temperature.

If, with little overlap, the valve and turbine temperatures stayed below acceptable limits at the highest mean effective pressure desired, then liquid cooling can control piston temperature.

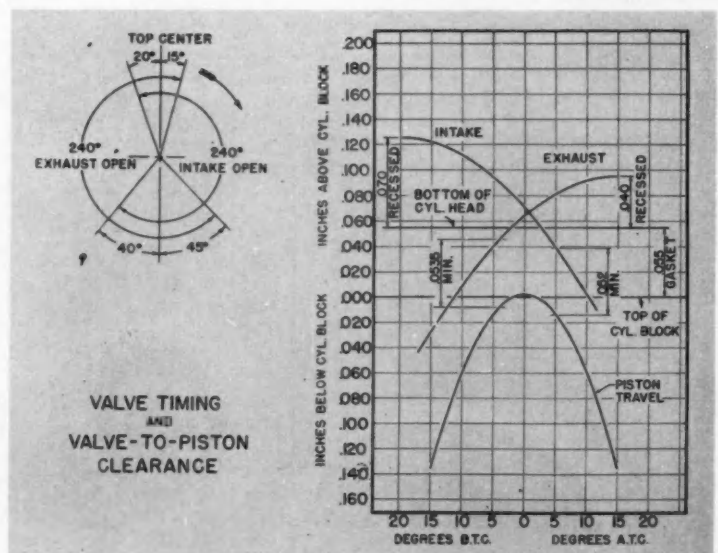
A valve timing which doesn't require valve clearance recesses was decided on (Fig. 5). The more cut-up the piston crown, the more initial swirl is needed to obtain the required final swirl rate. And if more initial swirl has to be imposed on the incoming air, more energy is required to achieve this result. This means that pumping losses will increase and volumetric efficiency decrease.

There is no indication of need for more overlap up to the highest mean pressures so far obtained — around 200 psi.

Single cylinder development

Combustion system work was done on single cylinder engines because it substantially reduces development time and cost. The exact combustion chamber configuration developed on the single was trans-

Fig. 5—Valve timing and valve-to-piston clearance.



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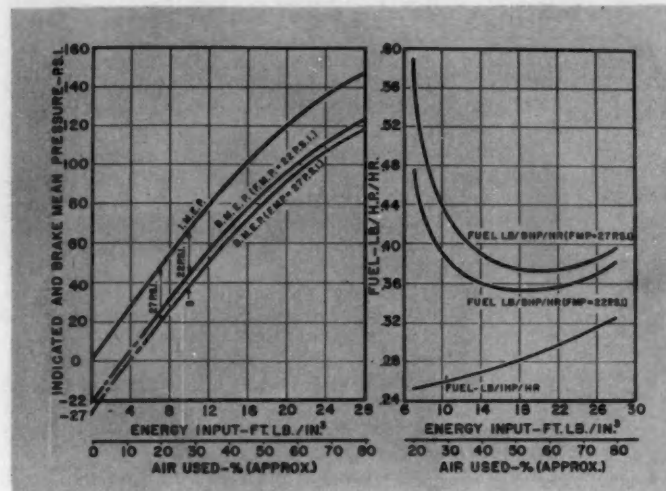
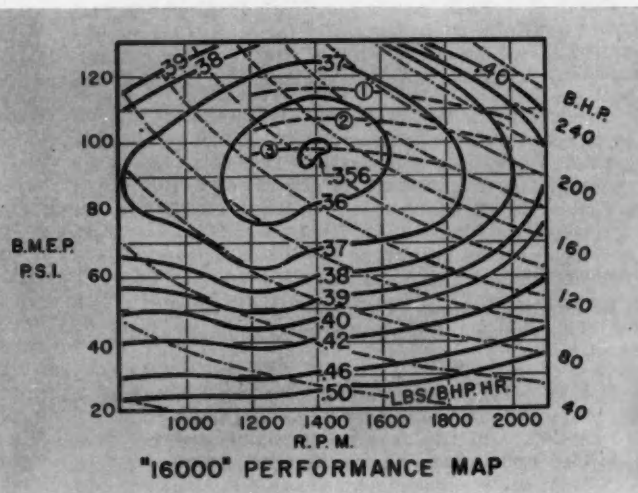


Fig. 6 — Plotting specific energy input versus brake mean effective pressure shows combustion efficiency.

Fig. 7 — Fuel economy of the 16000.



ferred to multicylinder production engines without even minor modifications. Optimum arrangement for both engines is the same.

Manifolding can have a great effect upon airflow pattern, and can cause the multicylinder engine to perform differently from the single. If this is the case, it is advisable to correct the manifold design of the multicylinder so that its effect becomes equal to that of the induction system of the single. This is preferable to tailoring airflow and injection to an unsatisfactory manifold.

Necessary development changes can be made on a single cylinder in less than one-third of the time needed to perform the same work on a six-cylinder engine. So any time required for additional analysis is well spent.

The only difficulty in correlating data is uncertainty about operating friction. The problem is solved by a method which evaluates indicated per-

formance without adding measured or calculated friction to effective pressure. This is done by plotting specific energy input versus brake mean effective pressure. The slope of this curve shows combustion efficiency.

In the right-hand part of Fig. 6 the uppermost curve represents the brake specific fuel consumption of a single cylinder experimental engine and the next curve that of the 6-cylinder engine having the same combustion chamber design, both operating at the same speed. It would be most difficult to tell from these curves whether or not the indicated specific fuel consumptions of both engines are the same. However, if it is found, after replotting this information as energy input per unit of displacement against brake mean effective pressure, that the resulting curves are parallel, it follows that both engines make the same use of the fuel supplied. The vertical distance between the curves then rep-

Combustion System for New Diesels

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resents the difference in operating friction. The indicated mean pressure curve must obviously pass zero so that, if the bmep curve is moved into this position, the indicated pressure is obtained.

Good fuel economy

Fig. 7 shows fuel economy of the 16000 engine. Curves of constant specific fuel consumption are plotted against bmep and rpm. Also shown are the rating curves for commercial engines. These curves are defined as follows:

Curve 1—Full power setting: Represents the power available at full throttle for engines to be installed in off-highway rubber tired equipment, for stand-by service or similar applications. Production

engines will produce horsepower within 5% of values shown.

Curve 2—Intermittent duty: Recommended power to be used for applications having varying loads and speeds with full power being required for short periods.

Curve 3—Continuous duty: Recommended power to be used for driving sustained full loads for 24 hours per day operation.

Performance was obtained under ambient conditions, and with standard air filters and laboratory exhaust system connected. The exhaust back pressure varies from 1 in. water column at low engine speeds and loads to 11 in. at the high end of the performance curve.

Fig. 8 gives fuel consumption contours for the 21000 engine as equipped with the standard turbo-charger. This unit is matched to cover most of the usual applications having governed speeds from about 1700 to 2000 rpm.

A different turbine configuration is used for "slow speed" applications in the 1200 to 1500 rpm governed range. The map of the last mentioned model is practically the same as the one shown, except that the contours are moved toward the left by 400 rpm and that they are lowered by about 18 psi bmep. This places minimum specific fuel consumption at 1300 rpm and 100 psi bmep. The peak of the .37 contour occurs at 1400 rpm and 160 psi bmep.

Excerpts from Discussion

Masked valves

B. Loeffler: Mack uses the tangential port. We feel it has several basic advantages over the masked valve:

1. A rotating intake valve keeps the valve seat clean by its sliding action, keeps the valve better sealed, and the seat doesn't look pockmarked.
2. The valve stem has no tendency to scuff. In fact, on a turbocharged engine it was found necessary to positively rotate the intake valve to prevent scuffing of the stem. The manifold pressure tends to remove the oil on the intake valve stem, aggravating the scuffing condition.
3. The flexibility with which the port velocity can be adjusted to the desired torque. Look at Fig. 4.
4. On the left hand side is shown the high torque at low engine speed, desired for a tractor engine such as the Allis-Chalmers. While a very desirable torque characteristic, it can't be used because the upper speed torque is very unstable. This is the result of the masked valve design. Had a tangential port been used, it would be possible to have the high torque at low speed and a uniform torque at the high speed.

L. D. Evans: It is stated that the directed port is not effective at the highest lift, whereas the masked valve is. We disagree with this view since our tests on directed porting indicate that swirl, even at high valve lift, can be equal to that obtained with masking and with no reduction in air flow. By means of

offset counterbores, the initial swirl is good and the port direction carries on the swirl up to the highest lift. We agree that the masked valve is an easier method of producing swirl but we also feel that additional development will provide a satisfactory port eliminating the use of valve masking.

Even though a satisfactory valve life is claimed by the author, the mechanism for controlling valve position, plus the additional valve cost, would seem to make it an attractive cost reduction item.

K. J. Fleck: We feel that valve rotation is a good feature to have, fully realizing that many engines do operate satisfactorily without rotation.

Valve overlap

Mr. Loeffler: It is interesting that Allis-Chalmers has retained the same timing events for the turbocharged as well as for the naturally aspirated engine.

We, at Mack, came to the same conclusion after some six different camshafts were tried with overlaps up to 120 deg. Large overlaps gave a slight gain in specific fuel consumption at the top speeds, but ruined the part-load, especially at lower speeds.

Such overlaps will do a creditable job on stationary engines, but this is quite different from automotive diesels that must operate over a wide speed and power range. Under those conditions, it is advisable to have an all around good economy.

Mr. Fleck: The Allis-Chalmers engineers should be commended in selecting a valve timing and other

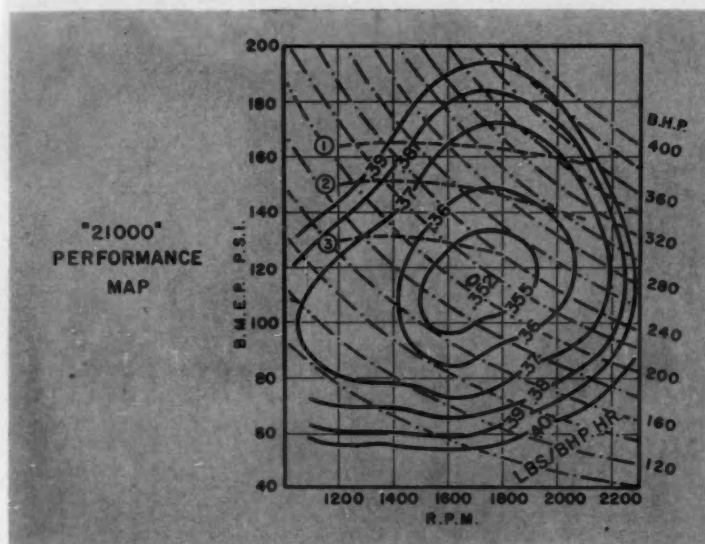


Fig. 8—Fuel economy of the 21000.

variables compatible with their system and in line with their objective and needs, rather than follow a general opinion blindly that high overlap was the only way to go. In the earthmoving industry the final engine design is sometimes a compromise for better low speed performance. It is my belief that higher overlap might be useful only if chasing after horsepower at high speeds.

Mr. Evans: In the original concept of this engine it was stated a normal valve overlap was decided on since piston temperatures could be controlled by oil cooling. However later on you indicate that the forced oil cooling of the piston is not utilized and splash is the only device used for carrying oil to the piston. We are interested in knowing whether you can depend on splash cooling on crawler units which are operating continually on steep inclines in a process of oscillating up and down a slope doing bulldozing work. If splash is the only means of cooling are special oil fingers used? Our experience indicates that valves also suffer when low valve overlap is used at high output.

Author's Reply to Discussion

Mr. Evans was quite right when he said: "The additional valve cost would make an attractive cost reduction item." Ours is a relatively costly arrangement. We feel, however, that the additional cost is well worthwhile as the masked valve contributes substantially to the engine's high fuel economy. Eliminating the masks, and using the arrangement advocated by the discussers, would increase the specific fuel consumption by roughly 5%. In the case of a hard working tractor this would mean some 4 gal per day so that it will not take many operating days to amortize the additional cost. More important, however, is what happens to these additional 4 gallons of fuel which would be passed through the engine every day. As they would not produce more useful work, they could serve only to form carbon, make smoke, heat the cooling water and the lubricating oil, and raise the exhaust temperature. None

of these would be desirable attainments.

We do not agree that there is something "flexible" about port velocity when a directional port is used. In this case, velocity and direction are functions of the shape of the port so that new port cores and, therefore, new and different cylinder head castings are required if velocity or direction of the incoming air are to be changed. This is no disadvantage if only one certain engine application, that is a single torque curve and a single rated engine speed, are expected from one engine model. If it is desired, however, that the engine be suitable for several different services and that it make the best possible use of its fuel in each of these, different initial swirl rates may be needed. To achieve these, it would be simpler to stock several intake valves having different mask angles than to carry in stock several different cylinder head castings.

In connection with Fig. 4, we would like to point out that the reduction in torque at 1200 rpm is in the order of 1.6% where as the gain at 2100 rpm is some 3.2%. The decrease in peak torque is not significant. But the gain at rated speed, amounting to more than 8 bhp in the case of the naturally aspirated engine, seems worthwhile, particularly since it is obtained without increase in fuel. It should also be remembered that this performance is obtained with fixed timing. We wanted to avoid a variable injection device, not so much because of its cost but to avoid additional mechanical complications, provided that this could be done without sacrifice in performance and fuel economy.

At this time, production engines do not use forced piston cooling. The fact that the engines are not being "pushed" and that they convert a high percentage of the total fuel input into mechanical output, keeps the piston temperatures low enough that not even fingers are needed. As has been implied, piston cooling will be used if and when we start, "to chase after horsepower".

To Order Paper No. 70T . . .

. . . on which this article is based, turn to page 6.

Problems make plain . . .

Cooling System Isn't

NEGLECT of the cooling system, while engine power and speeds were increasing and emphasis was being placed on styling, has created a cooling problem approaching the critical. This problem will not be solved without getting back to fundamentals—to examining and improving circulation and airflow.

Circulation is seriously impaired by entrainment of air in the coolant. The aeration, which includes a mixture of water vapor, combustion products, and air can lead to improper cooling, corrosion, premature failure of engine parts, or loss of the engine itself.

THE MATERIAL for this article was drawn from the following papers:


"Headaches and Aspirin for Cooling Systems,"
by **C. S. Morris**, Caterpillar Tractor Co.
(Paper 77T)

"Coolant Circulation as It Affects Engine Cooling,"
by **J. C. Miller**, Cummins Engine Co.
(Paper 77U)

"Radiators—and then Deaeration,"
by **R. C. Jensen**, Perfex Corp. (Paper 77V)

"Let's Appraise the Fan Function,"
by **T. J. Weir**, Schwitzer Corp. (Paper 77W)

"Engine Cooling and Automobile Styling,"
by **D. H. McPherson** and **P. J. King**, Chevrolet Motor Division, General Motors Corp.
(Paper 77X)

 To Order Papers Nos. 77T, U, V, W, X
... on which this article is based, see p. 6.

Aeration comes about from six sources. These are:

1. Aeration in the top tank because of high-velocity inlet flow splashing against the opposite tank wall and mixing with the air above the coolant level.
2. Generation of water vapor because of a lack of sufficient net positive suction head at the impeller eye of the coolant circulating pump.
3. Air leakage past pump seals caused by vacuum condition at the pump inlet.
4. Pockets of air in the engine cooling passages, hose lines, and cab heaters.
5. Air pulled into hose ends past loose clamps, especially in the hose connection between radiator bottom tank and pump inlet.
6. Exhaust gas from leaking cylinder head gaskets.

The sad facts of aeration

The heat carrying ability of water vapor or air is less than water or the commonly used antifreeze coolants. A coolant with a low heat carrying ability will not be able to take sufficient heat from the engine, nor will it be able to transfer all of this heat to the radiator or other heat exchanger. Both will lead to higher engine temperatures.

Air entrainment increases the possibilities of pump cavitation, consequently, reduction in coolant flow, leading to a reduction in radiator cooling capacity and engine corrosion.

When a unit is shut down and allowed to cool, the contraction of water or coolant allows air to enter the system, usually in the radiator top tank through the overflow tube. If this air is entrained it expands as heated and an equal volume of water is displaced. Thus, more air is entrained and as the air to coolant ratio increases, the circulating pump

Doing Adequate Job

becomes less effective because of air-lock, and an almost complete loss of cooling can occur.

Reduction in flow

The amount of entrainment is primarily a matter of top tank design and the water level. The flow characteristics of a system with a top tank of limited volume is shown in Fig. 1. By providing a petcock at the highest point, the top tank could be completely filled. At this condition the water flow was set at 80 gpm. Water was then withdrawn, 1 qt at

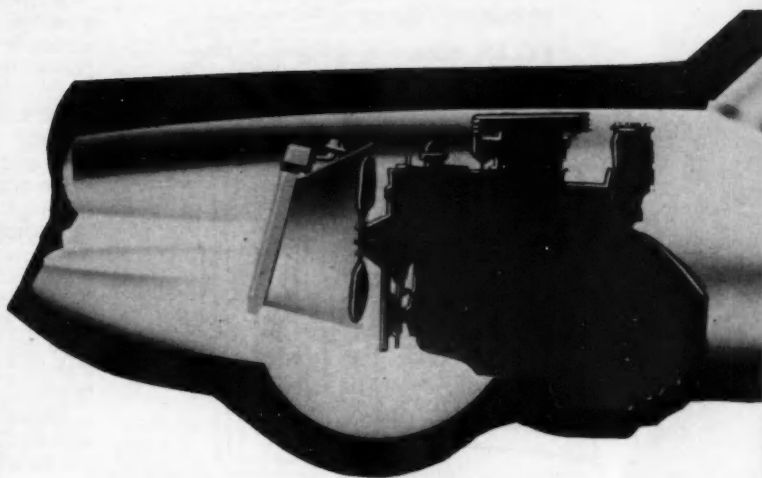
a time, and the effect on flow plotted. At 3 qt from the complete full point (approximately the normal expansion space provided), the flow was already affected by entrained air. At 7 qt low, just 4 qt below the normal fill point but still above the tubes, the flow was reduced to 55 gpm. Some instability of flow was apparent, which could become critical with water near its boiling point.

With a new top tank designed to avoid entrainment of air and to give greater volume, 11 qt of water could be withdrawn before the flow was affected at all, and the circulation was crystal clear

A look at the future

It is to be hoped that trends in styling will emphasize the functional necessity of engine cooling in the modern high-powered car. This could be done by making the radiator a classic feature, but still better would be to follow the lead of aircraft designers and use the clean, aerodynamic lines of the jet engine induction system.

If the present trend in hood heights continues, a possible solution is an installation similar to that found in the Corvette, wherein the radiator is tilted (shown at right). This requires a full shroud rather than the conventional ring type. Another approach is the cross-flow radiator with a separately mounted top tank. However, both these solutions add to cost.



Tilted radiator with full shroud, as exemplified by this Corvette installation, offers one way to get adequate cooling if the trend to lower hoods persists.

Cooling System Isn't Doing Adequate Job

... continued

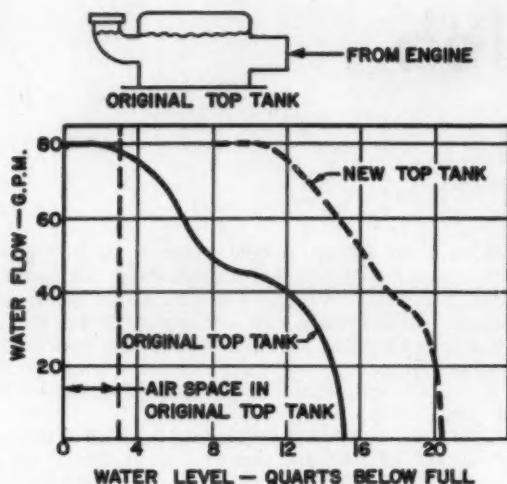


Fig. 1—Effect of water level on flow shown by comparison of results with an inadequate top tank and one designed to avoid air entrainment and giving greater volume.

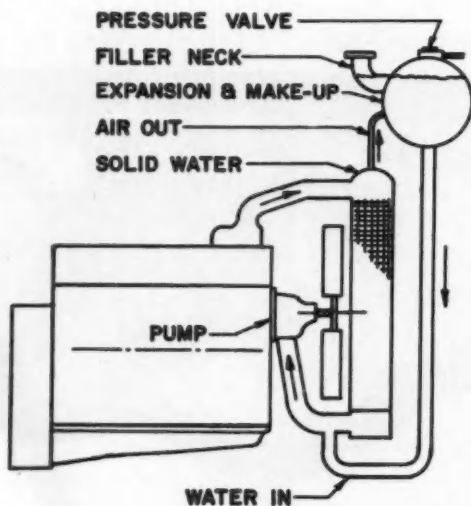


Fig. 2—This basic circulating system provides the means for purging entrained air, replacing the purged air with coolant, introducing the coolant into the top tank under coolant level to avoid reentrainment of air, while allowing ample volume for make-up, expansion, and after boil.

once the initial entrained water was purged from the system.

Solutions to Entrainment Problem

There are four basic requirements for a satisfactory circulation. These are:

1. Circulation to get the air out.
2. Circulation to get make-up coolant back in.
3. Introduction of the coolant into the top tank under the coolant level.
4. Ample volume for expansion, make-up, and after boil.

These principles are illustrated in the basic system shown in Fig. 2. The auxiliary tank provides a quiet area where the air can separate out if necessary. The air, purged through the small line, is replaced by coolant from the auxiliary tank through the larger line to the low-pressure side of the system. This circulation of air out and coolant in fills the top tank. It is maintained in full condition by a constant small circulation of coolant from the top tank to the auxiliary tank, and from there to the low side of the system.

Since there are occasions where there is insufficient room to mount an auxiliary tank, which may also be costly, cumbersome, and susceptible to damage, another solution is to build a surge tank into the radiator top tank. Such a design is shown in Fig. 3.

Increasing fan efficiency

It takes space for good fan performance. An overall fan efficiency of 50% or more can be attained in the proper environment. This takes close attention to shrouding, a good entrance venturi, close radial tip clearances, and unobstructed entrance and discharge, and a good match between fan design, speed, and system resistance.

If we assume the best possible design of fan, radiator, shrouds, and installation, and that a cooling of 190 F top tank with 100 F ambient, full engine power has been achieved, what happens to engine water and underhood temperatures when other than maximum power or maximum temperature is met?

If ambient temperature drops 50 deg with the same engine output, a drop in top tank temperature to 140 F and a drop of 50 deg in air temperature underhood would be expected. Since the fan cannot sense changes in condition, an overcooling situation occurs at all times except when maximum cooling requirements exist. Engine water temperature is too low, fuel is wasted driving the fan, engine oil tends to sludge, and carburetor air (in a gasoline engine) is too cool and the result is poor economy.

Thermostatically controlled shutters afford a partial solution, but when the shroud is closed the fan horsepower increases and the fan noise level rises.

Solution to overcooling

A thermostatically controlled fan seems to offer the best solution. Such a unit is shown in Fig. 4. The temperature control unit is a Detroit lubricator

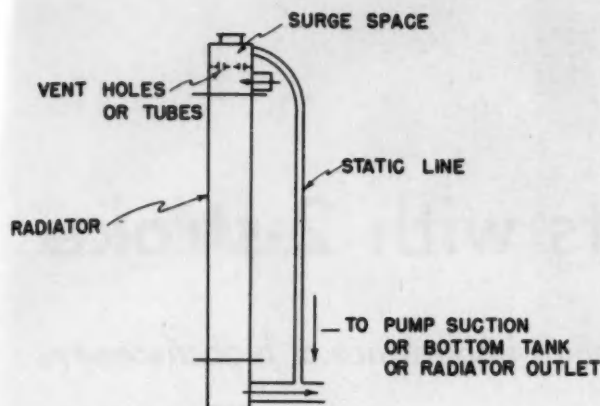


Fig. 3—Instead of mounting an auxiliary tank, the surge tank for deaeration of the coolant is incorporated in the radiator top tank.

Vernatherm mounted at the water pump impeller. A push-rod from the element mates with the control piston in the drive changing clearances between driving and driven plates. The housing is partially filled with silicone fluid and a difference in the thickness of the fluid film changes the torque capacity of the drive.

Fig. 5 shows the results of tests with this fan unit in a gasoline-powered truck rated at 65,000 gw. It is noteworthy that the difference in cooling between 10- and 50-mph vehicle speed is about 10 deg. With 50-mph velocity, fan speeds above the minimum drive speed did not occur until ambient temperatures reached about 60 F. At 10 mph, fan speed starts to increase at 30 F. With the minimum fan speed at low ambient temperatures, an 85-deg air temperature rise through the core was obtained, whereas with full fan speed a normal air rise of about 45 deg was obtained.

Favorable results were also obtained at one-half engine throttle with engine speed at 85% of governed speed. And all tests confirmed the advantage of using a controlled fan to save on fan horsepower, and horsepower absorbed by the fan varies as the cube of the speed.

Tractors suffer, too

Construction equipment has its own peculiar cooling system problems. Track-type tractors, for example, suffer from core plugging most frequently when engaged in land clearing. No matter how big a core is, if it cannot pass air it won't be effective. Screening helps, but screens must be kept clean. Blower-type fans are used to blow air through the core from rear to front, but they have to be guarded with screens and they restrict airflow. Self-cleaning fans help to keep debris from collecting in the core, but this type requires twice the horsepower of a conventional fan.

Any built-in air restriction must be paid for in fan horsepower or overheating. Front mounted equipment can seriously restrict airflow, and if this is designed for, there will be excess capacity when the equipment is not used.

Tractor operators demand a seasonal change in

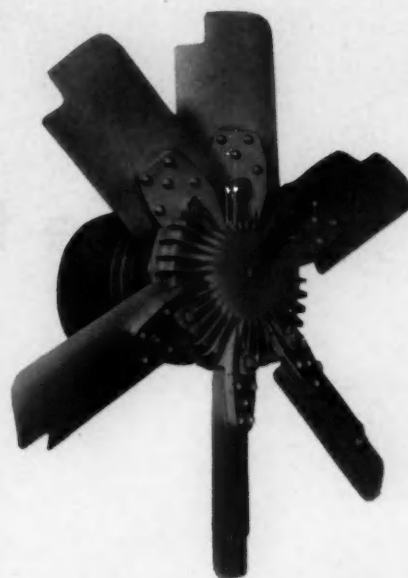


Fig. 4—Thermostatically controlled, variable-speed fan can solve the problem of overcooling. It assures that fan will not be driven at speeds in excess of that needed to maintain desired engine water temperature.

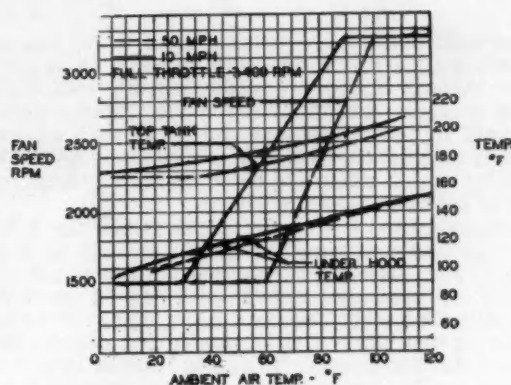


Fig. 5—Plot of tests with a 65,000-gw gasoline-powered truck shows the advantages of using a thermostatically controlled, variable-speed fan.

fans. They want suction-type fans in cold weather and blower-type fans in summer. This is the opposite of conditions desired for effective cooling.

Sandblasting of cores often occurs on a machine equipped with a blower-type fan, due to the high tip speed.

Finally, there is the problem of make-up water, which can be anything from treated water to muddy ditch water. Dirty water can wear away a water pump seal and cause the valves of water temperature regulators to stick open and cause overcooling. A good rust inhibitor should be used to prevent corrosion and fouling of components.

Lube tests with 2-stroke

...show importance of high viscosity,

thorough mixing, and

Based on paper by

A. Towle

Lubrizol International Laboratories (England)

SURPRISINGLY high ratios of fuel to oil can be used with high V.I. SAE 50 stocks in 2-stroke engines without danger of piston seizure, but these ratios decrease substantially for oils of either lower viscosity or lower viscosity index, so that an extremely high concentration of low viscosity SAE 10W must be used if seizure is to be avoided. These results of tests are shown in Fig. 1.

Although, over the range of oils tested, the ratio of oil to fuel that could be used appeared to vary linearly with viscosity, such a relationship would obviously not hold over more than a limited range of viscosity. Moreover, the limiting value of fuel to oil will differ with the type of engine and operating conditions, but the general trend with regard to piston seizure can be expected to apply to other engines under other conditions.

On some engines, connecting rod or main bearings may very well be the first to suffer when the fuel to oil ratio is increased abnormally. At the other end of the scale, oiling up of the spark plug and excessive deposits may occur on some engines with too low a fuel to oil ratio. This broad general trend has been substantiated by results obtained by the Thornton Research Center on a scooter engine, as shown in Fig. 2.

Importance of bright stock

Comparison of the limiting fuel to oil ratios for SAE 30 oils made up of blends of distillate and bright stock suggests that the optimum antiseizure properties are obtained by incorporating as much bright stock as possible in the oil (Fig. 3). However, other tests indicated that high bright stock content leads to an increased tendency to form port deposits.

Out of these tests certain facts, helpful in the selection of a suitable oil, became evident. These are:

1. High viscosity oils, such as SAE 50, do give best protection against piston seizure and better protection against bearing corrosion and wear, but tend to have worse port blocking characteristics than low viscosity oils.

2. Low viscosity oils, such as SAE 10W, give minimum protection against piston seizure and for safety's sake should not be used in ratios higher than 15/1. They do have the lowest port blocking tendencies, but on many engines are likely to give rise to troubles with excessive wear of piston bosses.

3. SAE 30 oils provide a compromise between the characteristics of SAE 10W and 50.

4. Thorough mixing is essential and unless preblended fuel and oil are available or the oil is diluted to be self-mixing, then the lower viscosity oils show up to advantage.

5. The base oil has little influence on ring sticking, internal engine deposits, and spark plug troubles, and there is comparatively little change in these deposits with increase in oil to fuel ratio.

Detergents have real value

Many oxidation inhibitors show up to no advantage and may be deleterious as regards spark-plug troubles. On the other hand, detergent additives, particularly alkaline types, even in concentrations corresponding to the old 2104-B level, can virtually eliminate ring sticking, can result in almost complete internal engine cleanliness, and can eliminate some types of piston seizure. Whether they are beneficial as regards port blocking will depend upon the type of additive and the operating condition. Under any but extreme conditions, most alkaline detergents will reduce any tendency towards bearing corrosion.

To Order Paper No. 66T . . .

... on which this article is based, turn to page 6.

engines

bright stock,

detergent additives.

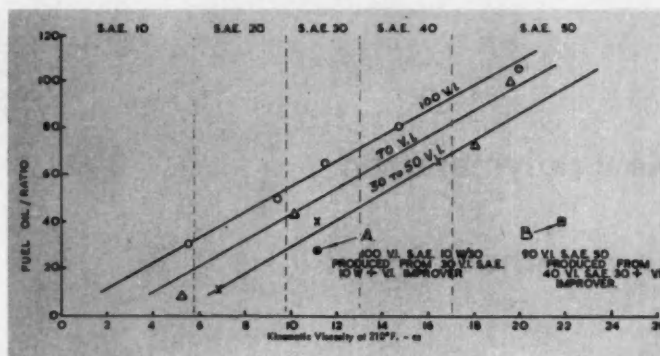


Fig. 1 — Limiting fuel/lubricant ratios for no seizure with oils of different viscosity and different V.I. in 2-stroke engines.

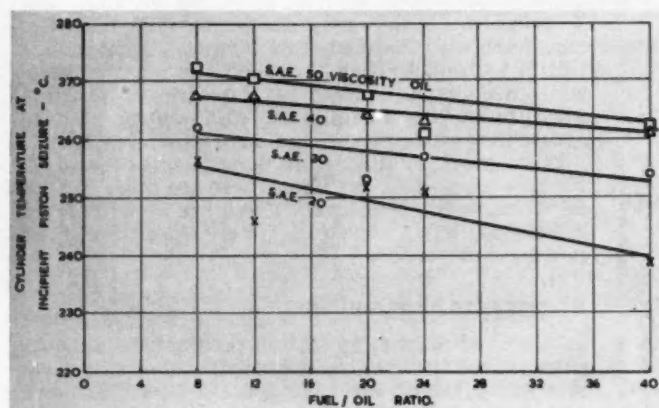
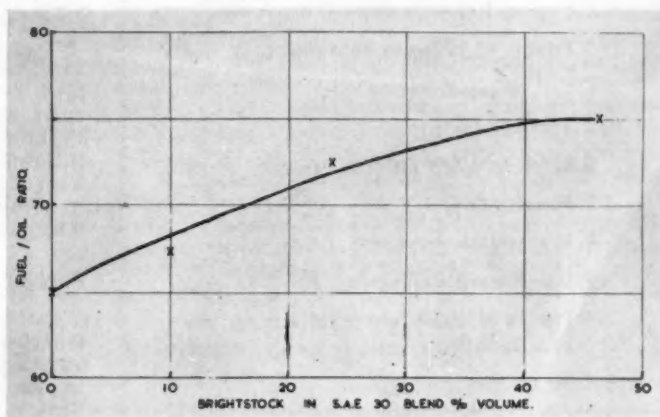


Fig. 2 — Influence of fuel/oil ratio on cylinder temperature at incipient piston seizure, with oils of different viscosities.

Fig. 3 — Effect of bright stock on limiting fuel/lubricant ratios for no piston seizure. All oils are SAE 30, 95-100 V.I.



New polymers and
new methods boost

Plastics for automotive

Based on paper by

J. H. Du Bois

J. Harry Du Bois Co.

Watch Out!

PLASTICS have their virtues and their weaknesses — fundamental limitations which must be met by design features. There are 10 well-known causes for the failure of organic plastics. These must be kept in mind when developing a new product and the polymer evaluated in the light of them. These are:

1. Lack of absolute age and dimensional stability.
2. High and variable thermal expansion.
3. Effects of moisture absorption.
4. Loss of plasticizer.
5. Weatherability.
6. Batch to batch material variation.
7. Flammability.
8. Low scratch resistance.
9. Low thermal endurance.
10. Effects of flame, electrical arc, and nuclear radiation.

THE development of new polymers offering new properties and new combinations of desirable characteristics, coupled with advances in manufacturing techniques, has expanded the plastics horizon. Still wider application now hinges in large measure on the imagination and ability used to create new products through design integration.

Since much of the future volume will depend on the new production methods, there are three of note on which to keep an eye. These are blow molding developments, fluidized polymer deposition, and potting compounds.

Advances in blow molding

Improved machinery now in process of manufacture will make blown plastics competitive with glass and metal containers. Windshield visors and arm rests having good safety features, desirable tactile surfaces, light weight, and reasonable cost can be blow molded of polyethylene or polypropylene. Bottles for windshield washers made of high density polyethylene now cost 25.5¢ compared with glass at 28-30¢. Accordion shaped bottles can be made to discharge by a simple mechanical linkage. Other possibilities are brake vacuum cylinders and bellows-type bottles for foot pedal windshield activators and for the accelerator and brake seal. Blow molding features low mold cost, fast tooling, and production flexibility, permitting design variations, color, and low product cost (Fig. 1).

The fluidized bed technique consists of immersing the product, after heating above the plastic's melting point, in a bed of fluidized plastic resin. After its removal, the residual heat serves to fuse the adhering plastics into a continuous film.

Potting compounds

Potting and casting compounds can simplify construction and assembly and assist prototype work. In this group are high-temperature resins, improved impact, flexible, and light weight foam products. New transparent and general-purpose casting resins

use

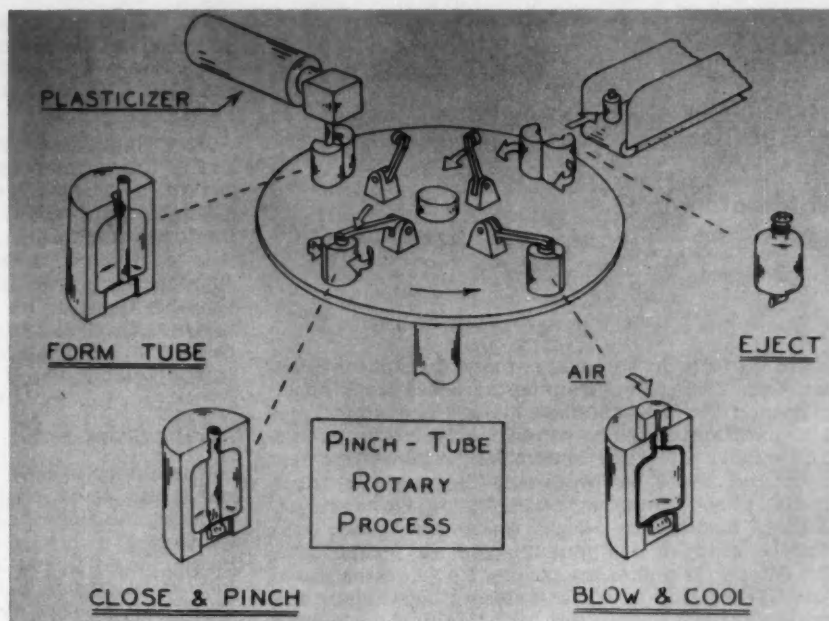


Fig. 1 — Pinch tube rotary process developed by Plax Corp. for blow molding hollow objects. The plasticizer extrudes a tube of plastic. As the die closes, the bottom of the tube is pinched and air is injected at the top. The object cools as the mold rotates and is then ejected by an air blast.

are available. Extensive use is being made of 500 F epoxy sealing compounds which may have adjustable flexibility.

Ignition coils of the future may have no molded case, being potted in an epoxy or polyester compound to improve cooling, end moisture penetration, and reduce cost. The distributor cap may become an integral cast unit composed of the several wires with terminals crimped in place and cast permanently in a minimum-cost potting compound. The cap would be impenetrable to moisture and be a throw-away item.

Phenolic materials

Sisal-filled phenolics offered by Durez and Rogers are replacing rag stock materials and certain polyester-glass premixes. They are inexpensive and can be molded at low pressure in cast steel molds. Applications are auto heater housings, air conditioning components, and some wet applications where conventional phenolics fail.

Glass-filled phenolics are gaining rapidly. A good example is the Durez-Chrysler oil pump gear which has proved superior to die cast aluminum (Fig. 2). Automatic transmission cones are being produced from this material by molding directly to tolerance without machining.

Where dimensional stability, minimum thermal expansion differential, high strength, and heat stability are required, a modified phenolic (Fiberite 4035 natural) with glass fiber is doing well. It is suited for complex insert assemblies where tightness must be maintained over a considerable temperature range.

Continental Diamond Di Clad 2350P, a new printed-circuit material, has electrical properties superior to Nema Grade X and is cheaper. It can be fabricated by punching and dip soldering to produce highly reliable wiring systems at low cost.

A new two-stage mineral and flock-filled molding compound — GE 12933 — exhibits improved resistance and dimensional stability, good heat resistance, and excellent electrical properties. A nylon flock-filled, two-stage phenolic — Rogers RX 725 — is very suitable for gears, bearings, and joints. A graphite-filled variety also has been introduced.

Styrene plastics

Styrene materials make the lowest cost thermoplastic molded products. High impact styrene will be used for injection molded ventilating shrouds on all 1960 Fisher bodies. The cost saving will be 60%. This material will replace compression molded polyester premixes. Styrene ABS (acrylonitrile-butadiene-styrene) polymers offer maximum toughness, high hardness and tensile strength, and can be injection molded, formed from sheet and fabricated by all conventional procedures. Potential uses are bezels, inner door panels, steering wheels, roof liners, and trims. A new compound (Kralastic MM) has an extremely high elastic modulus and other properties making it a potential competitor of the acetal resins.

New polyethylene applications

A new series of copolymers and alloys of polyethylene has enhanced this material by making it

plastics for automotive use

... continued

more uniform in shrinkage, more transparent, and more resistant to environmental stress cracking.

Among the new applications are vacuum-formed air conditioning ducts, windshield defroster nozzles and washer reservoirs, sun visors, heater adjustment cable and sleeves, graphite-filled linear spring inter-leads, plugs, antenna grommets, glove compartments, dashboards, deck trays, gas tank caps, formed seats or components, and air intake tubes for filters. It makes an excellent door water shield, and barbed shank, self-attaching polyethylene fasteners are growing in use for attaching dash liners and to fill holes during shipping.

Trilok, a three dimensional, structural fabric, produced by U. S. Rubber, employs the differential shrinkage between polyethylene and vinylidene chloride or nylon fibers in the weave. It serves for

light weight structural sections, filtration purposes, and self-ventilating cushions.

Polypropylene

Polypropylene has a greater tensile strength than any of the various density polyethylenes, is heat resistant, hard, glossy, chemically inert, light weight, moldable, and extrudable. It is heat sealable and its low-temperature flexibility point of -80°F is within the limit of automotive use. It is going into components, textile fibers, steering wheels, distributor caps, dome lights, lenses and bezels, valves, fans and housings, and films. Thermoformed sheet can be used for luggage, housings, duct work, and glove compartments.

Acrylic resins

The ability to cover metal with a weather-resistant, clear, hard, tough, many-colored coating has brought this polymer to the fore. A new type which gains 50°F in heat distortion temperature and can be immersed in boiling water indefinitely without loss of clarity is being produced by J. T. Baker Chemical and Dow Chemical under the trade names PL-11 and 12, and Zerlon, respectively. Implex, a Rohm & Haas modified acrylic, features improved toughness without loss of gloss or ability to be colored, and it contains no plasticizer.

Polyester products

Mylar (Du Pont) is transparent and flexible, has a tensile strength exceeding 20,000 psi, and is insensitive to moisture, chemicals, and solvents. Its dielectric strength is higher than other plastics and it will perform at temperatures between -140 and $+300^{\circ}\text{F}$. Having no plasticizer, there is no age embrittlement. Adhesives will bond it to itself and other materials. Metallized film can be used for metallic effects in upholstery material. Slot wedges of thin polyester film permit maximum copper in minimum generator and motor slots with adequate insulation.

Polyesters derived from isophthalic acid (Oronite Chemical) have higher softening points than Mylar films.

A glass roving-filled diallyl phthalate product has high impact strength and may give improved service in ignition and electronic applications requiring stability under high humidity. Design integration permits substituting polyesters for steel with economy.

Nylon plastics

A new hydrolysis resistant nylon resin, (Zytel FE2281) can be used in the cooling system, an example being an antigurgling device mounted in the heater base inlet assembly.

Glass-filled nylon such as Fiberfil (Fiberfil, Inc.) increases the tensile strength by 50%, impact by 122%. Heat distortion temperature is increased 230% at 264 psi, deformation under load is reduced one-third, and linear thermal expansion is cut 30%. This nylon has reopened the bearing cage application to the thermoplastics.

A freon-filled Nylon 6 bag is used in a new Delco



Fig. 2—Chrysler precision gear made of glass-filled phenolic has outperformed its die cast aluminum counterpart.

shock-absorber as the cushioning medium. With displacement of the fluid in response to movements of the piston, the gas is alternately compressed and expanded within the bag so that gas and fluid are not mixed (Fig. 3).

Sintered nylon products

Sintered nylons are competing with sintered bronze, steel, and porous metal combinations. Produced by cold pressing and sintering with powder metallurgy techniques, the product is being used for bearings, cams, gears, seal rings, thrust washers, roller sliding shoes, piston rings, and pump vanes. Tooling costs for a sintered nylon cam, produced at a 50 million per month rate, were one-third that required for an injection molded nylon cam.

Delrin-acetal resin

Delrin polyoxymethylene (Du Pont) will replace many metals because of its high strength, stiffness, colorability, toughness, low static and low dynamic friction, solvent and abrasion resistance, low permeability, and good dimensional stability. Electrical properties will be satisfactory for most applications. Resistance to hydrocarbons is good and the resins are slow burning.

Delrin parts have performed successfully under the hood at temperatures higher than 250 F. Replacement of zinc and aluminum die castings for functional and decorative service can be anticipated.

Polycarbonate resins

The polycarbonate GE-Lexan has no more creep at 100 C than nylon at room temperature and is superior to Delrin in this respect. It reaches its point of best dimensional stability in less time than either Delrin or nylon. A clear variety produced by Mobay Chemical is suitable for hot lamp lenses. Important values of the polycarbonates are dimensional stability, impact strength, and heat resistance to 300 F. Typical applications are gears, bottles, electromechanical components, coil forms, cams, and lenses. Coil forms will withstand temperatures of 280 F without deformation or oxidation.

Epoxy resin compounds

Epoxy "welded" joints have high bond strength. Nearly hermetic seals can be made by vacuum impregnation with epoxy resins. New uses are instrument fastenings, small components, and trim. The bonds are vibration resistant and more secure than bolts or solder.

Use of core boxes cast from Epocast 11B (Furane Plastics) is a new development. The material is highly resistant to the abrasive action of sand blowers and is often cast about a foundry pattern and confined in the metal flask. No machining is needed after casting. Masterlite 320, a troweling compound, is a close match for mahogany and is used extensively in some pattern shops. It can be drilled, nailed, and fabricated with wood working tools.

Epoxy resin premix materials are gaining favor

What the automotive industry needs in the field of plastics

- An organic body solder with better cold impact properties than possessed by existing epoxies.
- An adhesive capable of bonding emblems and decorative moldings to car bodies.
- A plastic capable of replacing steel in car bodies. Glass reinforced polyesters have the properties but require the hand layup method of manufacture, which is unsuited for mass production.
- An adhesive eliminating riveting and welding operations.
- An abrasion-resistant and shatter-proof plastic to substitute for glass.
- A good metal plating process for the phenolics.
- Advanced studies to find the most effective methods for predicting the processability of plastics and to insure product uniformity.

for door panels, glove compartments, truck cabs, doors, and bodies. Because of their toughness they may be expected to serve as headliners and door liners with the decorative fabric molded into the resin, and adhesive bonding to the doors and roof. Reinforced seat forms will be used, filled with shaped, flexible polyurethane foam and covered with adhesive-bonded, textured plastic covers. This will produce comfortable, springless seat assemblies. The tooling potential of the epoxy resins is such as to warrant special study.

By proper hole and insert design, inserts can be epoxy-bonded in place after molding to achieve great holding power, freedom from leakage, and lower cost.

Silicone plastics

Silastic RTV 502 is a fluid, quick-setting, room-temperature vulcanizing silicone rubber. It re-

plastics for

automotive use

... continued

mains rubbery from -70 to +500F, provides excellent electrical insulation, resists ozone, weathering, and moisture, and absorbs mechanical shock. Uses are: sealing, caulking, and making impressions. Molded silicone rubber components can be used very close to engines where other plastics fail.

Teflon 100X FEP (Fluorocarbon)

Teflon 100X has the desirable properties of Teflon but its operating temperature limit is reduced to about 400 F. Automotive applications will include printed wire, seals, gaskets, bearings, engine harness jackets, hydraulic and fuel lines, corrosion-resistant coatings and all antifriction surfaces.

Ceramic fibers, 50% each of silica and alumina, coated with polytetrafluoroethylene and then molded into a homogeneous sheet produces the new material Duroid 5650 (Rogers). The fibers minimize cold flow, improve thermal conductivity to make a product suitable for high flange pressure seals, gaskets, and for highly loaded bearings.

A glass micro-fiber reinforced Teflon will withstand temperatures up to 550 F under corrosive conditions where lubricants cannot be used, making it suitable for sleeve or thrust-washer-type bearings.

Foamed plastics

A typical foam can be made to stretch 700% in length, withstand 150-psi pressure, and perform

well in a temperature range of -30 to +250 F. New applications will include foamed-in-place weather stripping and sound insulation on the fire wall and under the car body.

Pelaspam (Dow) and Dylite (Koppers), expanded polystyrene bead products, fill the need for a foam-in-place material to supplement styrene foam blocks. When confined in a retaining mold and heated, the beads expand and knit to form a rigid cellular foam product suitable for refrigerated truck bodies. Molded Dylite can be converted into a soft, resilient foam suitable for floor carpet underlay, dashboard crash padding, head liners, arm rests, and door paneling.

Vinyl resins

U. S. Steel has introduced a vinyl plastisol coated metal sheet which can be handled like steel. It can be drawn 30% without ill effects or underfilm corrosion. It can be colored and textured and is stable up to 160 F continuous exposure, or to 212 F for two days. A welding procedure permits fusion of the steel without damage to the vinyl.

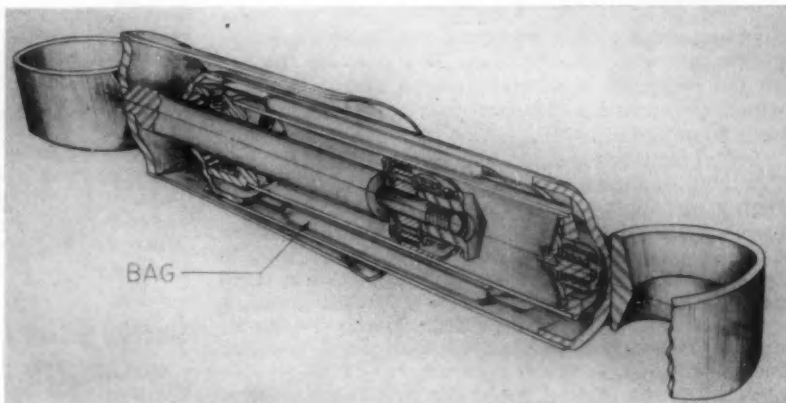
Chlorinated polyether

Penton (Hercules), a high molecular weight chlorinated polyether thermoplastic, exhibits a high degree of abrasion resistance, excellent dimensional stability unaffected by moisture pickup, and an ease of fabrication permitting it to compete with many metals in the corrosion equipment field. Applications could be valves, pipe, precision gears, carburetor and generator parts, protective coatings, and tanks.

▶ To Order Paper No. 82T ...

... on which this article is based, turn to page 6.

Fig. 3—Pliable cell of Nylon 6 envelopes the Freon 13 gas in this Delco shock-absorber. The sealed-in gas is compressed and expanded by the shock-absorber piston.



Spare tire elimination still stumps the experts

THE spare tire is on its way out. The space it occupies is wanted for other purposes, particularly in that new compact car. So the search for a satisfactory substitute is being pressed and although none has been found, tire producers are sure it will be — eventually.

Advances in tire construction have made the spare all but useless physically, but the psychological need is as great as ever. The motorist regards the spare as a form of insurance and he is not going to give it up and be happy with four tires until they are completely reliable or he is offered a substitute as good as, or better than, what he now has. And that poses the problem.

Proposals to solve the problem fall into four general groups. The first group comprises the stronger tire, the self-sealing, the dual compartment, multi-compartment, and built-in expansible tube.

The Goodrich "Life-Saver" and U.S. Rubber's "Air Guard" example the self-sealing type. The former has a layer of compounded material on the inside of the tire under the tread, which adheres to an object that punctures the tire. When the object is removed, the sealing material is drawn into the puncture to seal against air loss. The "Air Guard" employs an airborne sealant in particle size varying from the very fine to the nominally coarse. These particles tumble within the tire and in the event of puncture are swept to the point of air exit to form a dam.

Since carcass cuts and ruptures are second only to punctures in frequency, U.S. Rubber has developed a stronger tire (containing air guard) by reinforcing the undertread with randomly distributed fine, short pieces of 400,000-psi tensile strength wire, brass plated to assist in bonding.

Compartmented tires

The compartmented tire takes several forms. In one form, a tubeless tire carries an inner tube (or

diaphragm) uninflated. In event of puncture the tube (or diaphragm) is inflated to carry the car perhaps 100 miles or more (Fig. 1). This type requires carrying bottled gas or other inflation source. In another type, the tire and the inner compartment (both chambers) are inflated at all times (Fig. 2). In event of puncture, the inner compartment supports the car, permitting it to be driven to a service station.

Yet to be found for the dual compartment tire is a reliable low-cost warning signal to notify the driver that the outer compartment has been punctured so that he will not overdrive the tire before having it repaired.

According to Goodyear, producers of the "cap-

THIS ARTICLE is based on the following papers:

"Spare Tire Substitutes" (Paper No. 79T)

by **R. P. Powers**

Firestone Tire & Rubber Co.

"Progress Report of Spare Tire Elimination"

(Paper No. 79U)

by **R. E. Davies**

B. F. Goodrich Tire Co.

"Dual Compartment Tires" (Paper No. 79V)

by **Walter Lee**

Goodyear Tire & Rubber Co.

"How May the Spare Tire Be Eliminated?"

(Paper No. 79W)

by **H. B. Hindin**

United States Rubber Co.

To Order Papers Nos. 79T, -U, -V, -W ...

... on which this article is based, see p. 6.

Spare tire

still stumps

... continued

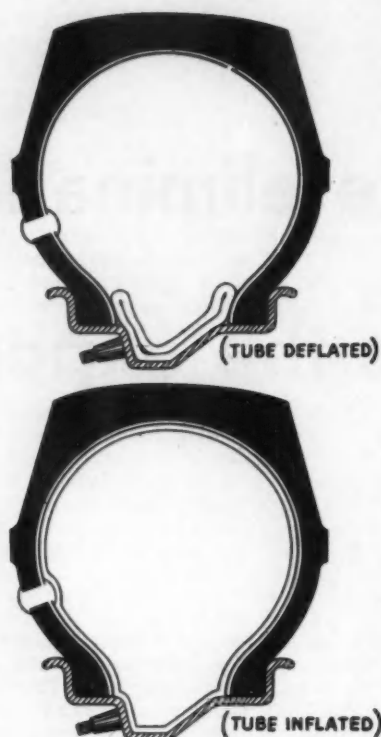


Fig. 1—Type of compartmented tire that carries an uninflated inner tube, which is inflated in the event of puncture. A similar type employs a diaphragm instead of a tube. Tire is inflated through the regular rim valve; tube or diaphragm through a sidewall valve.

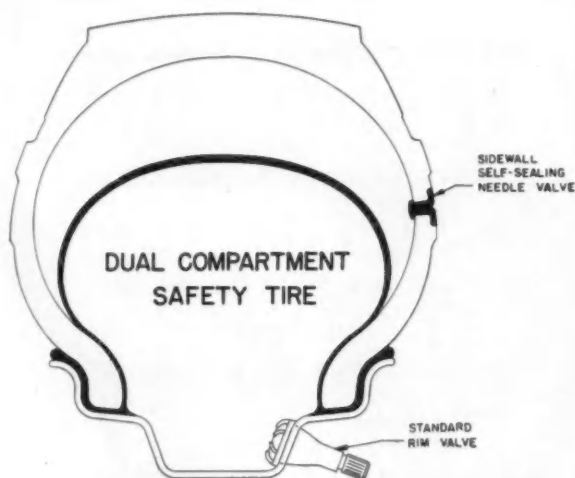


Fig. 2—Compartmented tire which carries an inflated inner chamber capable of supporting the car in event of puncture of the outer tire. This dual chamber type obviates the need of carrying an inflator.

tive air" dual compartment tire, safety depends on the incidence of failure of both inflated compartments. To approach the realm of acceptability such failure should not occur more often than once in 200,000 miles. In a test with a fleet of 166 taxi cabs, which ran for 19 months and covered just over 42,000,000 miles there were 1776 flats, but of these only 69 immobilized the cabs. In other words, the incidence of both compartments going flat was only 1.6 in 1,000,000 miles. The relationship between taxi service and public use has yet to be determined, but it is thought the dual compartment tire is at least 10-20 times safer than the present standard tire, and the expectation is to make it still better.

Multicompartment tires

Two types of multicompartment tires have been proposed. One is a tube with several unconnected chambers. From a manufacturing standpoint it appears to be prohibitive. A second type would have the tire filled with rubber or polyurethane cell foam. This would add weight and have different performance and temperature characteristics and does not appear to be practical.

The built-in expansible tube could take many forms. One is a tube-thick layer of reinforced rubber stretching from one tire bead to the other. Under normal inflation through a sidewall valve the band of rubber is forced into the well of the rim. In the event of a puncture, inflation through the regular rim valve forces the band against the tire to bridge the hole. This proposal has the drawback of requiring the means for inflation and it offers manufacturing problems.

Flat tire auxiliaries

The second group of substitutes comprises those which permit the flat tire to remain in place. Notables are the Perma spare, the pneumatic Perma spare, and a collapsing device which makes the flat tire load-supporting.

The Perma spare is a thin steel disc with rubber-covered outer edge which is applied next to the tire with regular wheel lugs. It is half the weight of the spare tire and wheel and takes about half the storage space. It could carry a car for 100 miles or more at 40-45 mph and be used over again. The pneumatic Perma spare is similar, but the steel disc carries a small pneumatic tire at higher pressure (Fig. 3).

An inflatable band which is placed around the

elimination

the experts

flat tire constitutes the collapsing device. It is constructed so that it bulges inward at six or eight places when air or CO₂ is forced into the band, thus collapsing the tire against the rim in segments. The tire now supports a load with the outer surface of the band acting as a tread. This device is difficult to apply, but will function for many miles if correctly applied.

Devices to replace the flat

Devices which replace the flat tire have one drawback — what to do with the tire when it is removed. The storage problem remains.

Suggestions for this group are the foldable spare, (with or without a wheel), a simplified Perma spare, and a small conventional tire on its own wheel.

The foldable tire is a two-ply affair with minimum tread rubber which can be folded into a small package. Flexible beads make it easy to snap on the rim. Handicaps are the removal of the flat tire, finding a place to store it, and carrying some means for inflation. Applying the foldable tire to its own wheel would save flat tire removal from its own wheel, but would not solve the space saving problem. In the simplified version of the Perma spare, the disc would be centered instead of offset, and need only be as thick as the rubber around the periphery, say about 2-2½ in.

Last in this group is a tire about the size of a motorcycle one. Its merit lies in reducing the size of space required to carry it as a spare.

New type of wheel

A fourth group of substitutes involves a new type of wheel which would permit easy removal of the flat tire. Doing away with the drop center rim and providing removable flanges is not enough because of the basic 5-deg bead taper, which requires a special tool to unseat the bead. The new type of wheel has a rim with different bead tapers — the back one over the brake drum being 20 deg, while the front one is 30 deg in the same direction. Once the flange is removed, the beads unseat themselves and the tire can be lifted off easily. This, of course, requires the use of different tire beads from those standard today (Fig. 4).

For this type of wheel an uninflated spare could be carried, easily mounted or dismounted. Or an inflatable 2-ply tire or tube, designed to fit the rim, could be used, for application after the flat is removed, or carried collapsed on the rim base. These have the merit of taking less space, but the drawback of requiring some means for inflating.



Fig. 3 — Pneumatic Perma spare comprises a thin steel disc on which is mounted a small, high-pressure pneumatic tire. Regular wheel lugs hold the disc close to the flat tire.

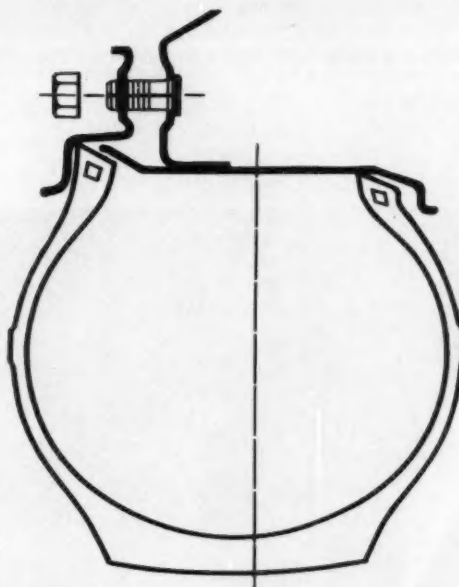


Fig. 4 — Easy removal of flat tires and equally simple replacement with substitutes features the Taper Lock rim. The rim has different bead tapers and the outer flange is removable; freeing the flange frees the tire beads.

Solving the brake heat

Abridgment of an
SAE Chicago Section Paper

Based on paper by

R. H. Long

Bendix Products Division, Bendix Aviation Corp.

THE brake problem is a heat problem and the way to solve it is to design to withstand the heat, get rid of it, or use a combination of both.

Brakes which combine conventional linings with a small insert of ceramet material have great ability to live with heat and some capacity to get rid of it. Removing heat from the very surface of the brake drum at the area of contact lining has considerable value. A number of combinations show phenomenal resistance to fade and there is an even more im-

pressive immediate recovery after fade. Noise and over-recovery are the problems which are now being worked on.

Caliper brakes coming?

The caliper or spot disc brake can live with some heat and has a great ability to get rid of it because the surfaces of the disc are exposed to the surrounding air for cooling during the major part of the revolution. This brake has very little self-energizing and so the heat effects on linings do not affect performance as much as they do in the more highly energized type.

The caliper brake can be actuated by one or more pairs of hydraulic cylinders. On small or light vehicles the idea is to use a single pair in the interest of economy; heavy vehicles can use a double pair. There is a limit to the diameter of the cylinders. They must be located between the outside of the

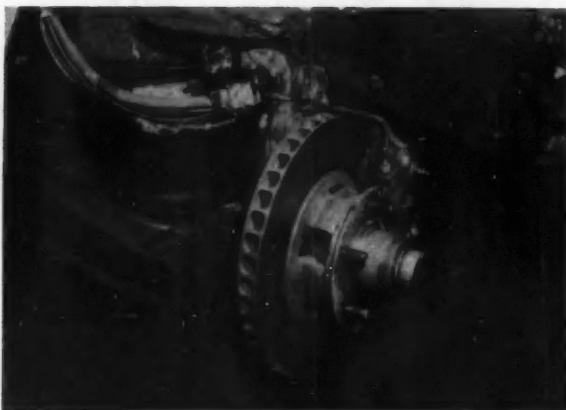


Fig. 1—Disc brake rotors provide radial air passages for forced-draft cooling. Tests confirm their contribution to heat dissipation and brake performance.

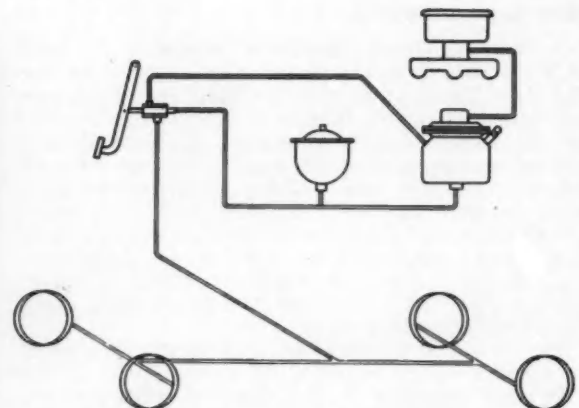


Fig. 2—Full power braking system lifted, as it were, from a central hydraulic system as a whole. The brake is operated by a relatively small movement of a control valve and there is instant and accurately graded reaction to give the driver a good sense of control.

problem

brake mounting flange and the rim of the wheel with sufficient room for the supporting structure. The latter must be very rigid to avoid the deflection, which reflects in a spongy pedal feel.

Tests are now under way to determine the advantages of disc brake rotors as heat dissipators and performance boosters. The rotors are provided with radial air passages to give forced-draft cooling, as shown in Fig. 1.

There is a marked trend to the caliper disc brake in England and on the Continent, but whether of not a similar trend will develop here is difficult to say because of the great difference in the way cars are driven. Caliper disc brakes for front and rear have been investigated and found satisfactory, but there is a cost penalty. For this reason a combination of disc brake at the front and a shoe brake at the rear is more practicable. A nonservo floating shoe brake at the rear is an ideal companion for a front caliper disc. Since little self-energizing is used at front or rear, the use of a power system seems to be a certainty. And this opens up the possibility of using a central hydraulic system for the brakes as well as for other power components. With shoe brakes at the rear, a parking brake is more easily adaptable and a smaller outlay for equipment and tooling would be required.

In search of safety

To make possible braking even though a leak develops in the system, a split hydraulic system has been brought forward. It comprises a vacuum hydraulic power brake unit in which the combination of the effort put forth by the driver's foot and the vacuum power device is applied to a central hydraulic piston. This displaces fluid for actuation of two supplementary hydraulic pistons, each connected to the system, operating brakes on one axle only. If fluid should leak from the front-axle system, the rear-axle system would still operate, and vice versa.

The phrase "split hydraulic system" also describes a system which is split into front and rear sections so that a device can be inserted in one section to regulate the proportioning of braking effort between front and rear in accordance with vehicle deceleration. The true split system is a design for safety

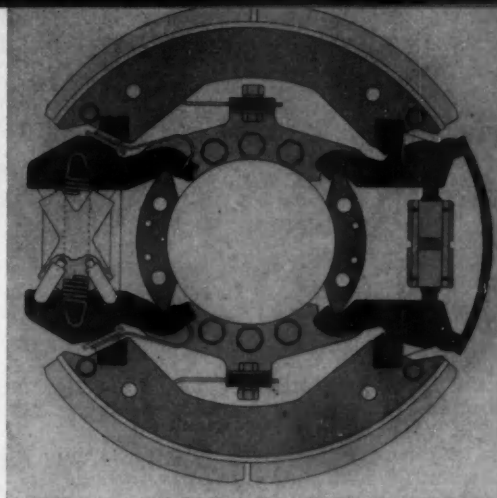


Fig. 3 — Wedge-actuated brake, which combines the two-leading-shoes principle with one actuating element. Both shoes do equal amounts of work; drum and wheel bearing loads are equalized. The single actuator means easy installation, less air or hydraulic fluid, and lower cost.



Fig. 4 — Water-cooled, commercial vehicle brake has possibilities for rugged country because it lessens the need to change gears.

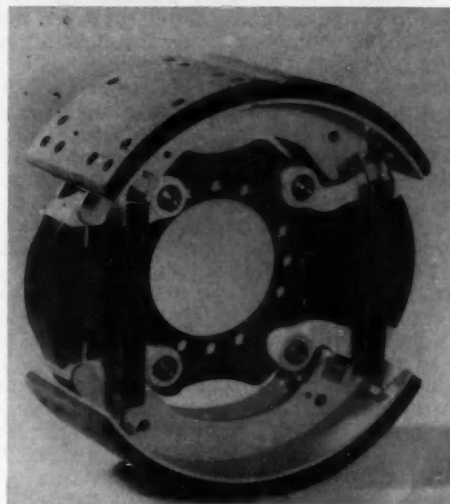


Fig. 5 — This brake introduces the simplicity of internal hydraulic actuation of the two-leading-shoes principle to the heavy-duty truck field. Block lining and ruggedness are comparable to the existing S-cam brake.

brake heat problem

... continued

and the brake proportioning device has the major advantage of increasing maximum deceleration by keeping the rear wheels from sliding.

Fig. 2 shows a full power braking system lifted from a central hydraulic system as a whole. In this case, the source of hydraulic pressure can be a vacuum-operated hydraulic pump, as shown at the right center of the sketch, because large volumes of fluid are not required, as they are in a complete central hydraulic system.

Commercial vehicle brakes

A redesign of the S-cam brake for air actuation is under test. Revised cam followers have reduced friction, eliminated the need for lubrication, increased stability, and increased efficiency as much as 20%.

Nine sample sets of a wedge-actuated two-leading-shoes brake were made up and put into operation 10 years ago by the Greyhound Corp. Most of the brakes are still in operation after rolling up an average of more than 1,000,000 miles per vehicle. Lining wear, general overall performance, and brake life have been outstanding. Now a redesign of this brake, simpler in construction, is being tested. Special attention has been paid to eliminating friction points in the brake.

Another wedge-actuated brake, combining the two-leading-shoes principle with one actuation element, is shown in Fig. 3. It is a balanced brake, both shoes doing an equal amount of work, with drum loads and wheel bearing loads equalized. The brake is air or hydraulically actuated, depending on whether an air chamber or hydraulic cylinder is used to operate the wedge. The single actuator makes for easy installation, requires less air or hydraulic fluid for operation, and costs less. Moreover, the wedge actuation permits a hand-operated parking brake to be incorporated in the wheel brake.

One effective way to get rid of heat in commercial vehicle brakes is to employ water cooling. The water-cooled brake shown in Fig. 4 has advantages in hilly country where it is desirable to control maximum speeds with a minimum number of gear changes.

The simplicity of internal hydraulic actuation of the two-leading-shoes principle is introduced to the heavy-duty field with the design shown in Fig. 5. It has block lining and ruggedness comparable to the current S-cam brake, and has promise as a heavy-duty truck, truck-tractor, and trailer brake.

Propeller shaft brakes are being improved. Cost-reducing improvements, primarily in mechanical cam actuator mechanisms, are being carried on in the 7-, 9-, and 12-in. diameter sizes.

To Order Paper No. S199 ...

... on which this article is based, turn to page 6.

guidance and control

Organization

Based on report by secretary **John Cooke**

Bendix Aviation Corp.

NEW personnel policies and practices are needed to complement the changes taking place in organization structure of guidance and control system manufacturers. The quest for greater quality, too, is demanding personnel policy changes.

Organizational Structure Changes

The "total systems contract" approach to government aircraft and missile production places full responsibility in the hands of the prime contractor. This method has greatly altered the internal organization of the guidance and control system manufacturer.

Today, the prime contractor for a vehicle controls the entire program and carefully places his subcontracts after gaining assurance that the manufacturer can, and will, adequately fulfill the simultaneous requirements of design, quality, and delivery.

It is the practice of prime contractors, therefore, to conduct sharp appraisals of the subcontractor's capabilities, usually with intensive interest in the internal organization that will support the project. This interest in the organization has led to questions, the questions have led to analyses, and the analyses to recommendations.

Prime contractors are recommending separate operation for the individual project within the guidance and control manufacturer's plant. As a result, we find the joining together, as an operational unit, of the direct, indirect, and service functions of each project. The project is then placed under a chief executive and becomes isolated, organizationally, from the rest of the plant. (It is, in fact, a product decentralization of a geographically centralized operation.)

For the prime contractor this method insures executive attention to the project commitments. For the subcontractor, it lends cohesiveness to the project group, with all the attendant advantages of closer engineering-manufacturing liaison, increased manufacturing feedback for design purposes, team spirit, accounting separation, and the like.

Although the advantages of project autonomy within the plant organization have been extolled at length in modern management journals, there is still some concern being expressed for the human problems that develop when radical and "temporary" organization changes are made. It may very well be that the tradition-bound concepts of organization are obsolete in this age of projects, but, if they are, there remains the job of finding replacement organizational techniques that are not riddled with human and industrial relations problems.

system manufacturers find:

Changes Make Personnel Problems

For instance, what do you tell the purchasing agent who is "lifted" from the traditional purchasing department to head the separated purchasing activity of "project tomorrow"? Is it a promotion that he faces, or a dead end? Is he in a "show-case" or a "cage"? Where will he go when the project ends? The long-term human relations factors involved in such organizational revisions might very well return to haunt the management.

Managers are currently handling the matter in a positive way. They recognize the sensitivity of the problem (which is a significant sign), and are following this line of reasoning:

"The autonomous project is here to stay because it represents a far more efficient organization. As one project closes out, others will take its place. Therefore, the only real change is that there will be more middle management opportunities available. On the new projects there will be greater delegation of authority, reduced spans of control, and other highly valued organizational improvements."

The argument is concluded by stating, "The new project organization will be the stepping stone to promotion and a vehicle of education for the men selected." In this analysis there are some highly important implications. There will now be a broader area for promotion to responsible position, and there will be a breaking down of the tendency toward one-man control and "kingdom" building. The ambitious individual welcomes this kind of change.

Perhaps the problem is actually an opportunity, but there is certainly an internal selling job to be done. In the meantime, careful attention must be paid to the balancing of salary levels and to the general plant structurings, with an eye toward the prevention of wage distortion and organizational imbalance.

Personnel Shifting

Advanced technological demands of the new guidance and control systems require the integration of more trained engineers into the manufacturing function. This raises the age-old dilemma of shifting the engineers' physical and psychological orientation from a thing-centered activity, to a people-centered activity. The pitfalls of this shift are legion; mismanagement of people, uncooperativeness, labor relations problems—yet, the fact remains, the integration must take place!

Management can resort to the often-successful technique of providing an interim training program for the engineers selected to work in production; or, if time permits, they can anticipate the problem and provide a factory internship for all "fresh-out" engineers to give a foundation for subsequent shifts. Having a first-hand knowledge of manufacturing, its joys and sorrows, often catalyzes the engineer's

decision to move. Needless to say, the salaries and prestige of a manufacturing position must equate with those of the engineering section before anyone will choose the shift.

One fact, however, is certain—the need for engineer-managers is growing. Today, there is broad resentment in the factories toward a lack of sympathy for the manufacturing problems on the part of the engineering sections. Unfortunately, the traditional factory-grown manager is often unable to cope with this problem for lack of technical competence in the advanced product field. There is little doubt that increased engineering capability in manufacturing will lead to the amelioration of the problem.

Quality and Personnel Policy

The demands of new products will tax the operator as well as the machine. Requirements are moving into a tolerance area as yet unknown and equipment alone will not produce the product. Until equipment can be upgraded, we must depend upon the sharpened skills of the operator to produce the mechanical tolerances. This, too, has resulted in definite personnel policy changes.

A new philosophy of training has to be pursued, one which cites the "one-in-ten-thousand" error as being acute. The individual's attention to detail is as much a component of success as is the alignment of a jig. These delicate processes must be entrusted to skilled, self-monitoring craftsmen who are proud of their rare abilities.

This same competence must be built into the quality control function. In much of this precision work the inspection force has to be increased to a 1/4 ratio versus a 1/8–1/12 range for other electronic work. But increases in force are not the whole answer to the problem. The individuals attitude toward the work must be positive. It must be supported actively through quality campaigns, highlighted prestige factors, and special recognition. These synthetic supports will have to do until more scientific process controls can be developed.

Serving on the panel which developed the information in this article, in addition to the panel secretary, were: **M. F. McCammon**, Bendix Aviation Corp.; **S. C. Donnelly**, Western Electric Co.; **Charles McWilliams**, Bendix Aviation Corp.; **Elmo Pillsbury**, Fairchild Engine & Airplane Corp.; **H. E. Rice**, General Electric Co.; and **V. E. Ryb**, General Motors Corp.

(This article is based on a secretary's report of a production panel entitled "Guidance and Control." This report—along with 6 other secretaries' reports on various production subjects—is available in multilith form as SP-327. See order blank on p. 6.)

Ultrasonic Fluid Inspection

as well as

Based on report by

Warren Strittmatter and Charles Albertson

Grumman Aircraft Engineering Corp.
(Presented before the A-6 Contamination Control Panel of the SAE
Aircraft & Missile Hydraulic & Pneumatic Systems &
Equipment Committee)

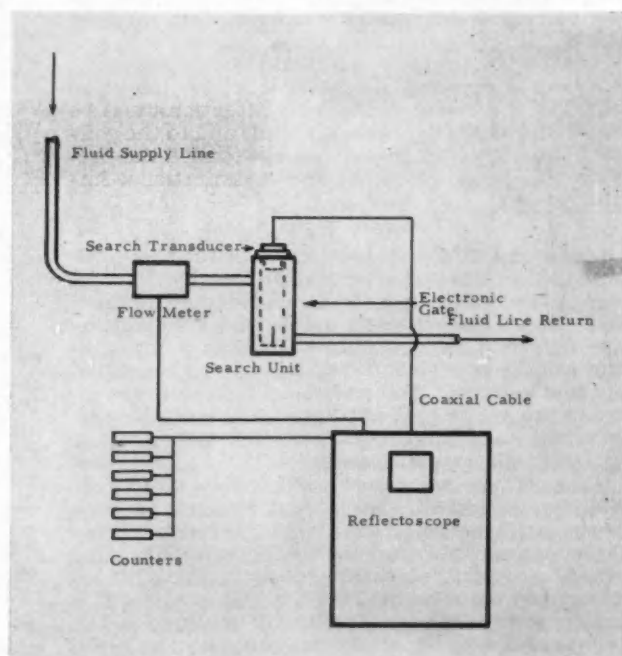
ULTRASONIC testing equipment has inspected ALL the fluid in an aircraft hydraulic system in one-fortieth the time required for a microscopic examination of a single filtered sample.

Development work shows it can measure fluid con-

taminants of one micron or larger, under either static or dynamic flow conditions. It will also count, in discrete band widths, particles larger than 10 microns.

Fig. 1 is a schematic of the experimental system developed by Grumman in conjunction with Sperry Products Co. of Danbury, Conn. The system was originally conceived for the inspection of aircraft hydraulic fluids and conventional fuels. However, it has also been applied to a variety of fluids ranging in temperature from -298°F (liquid oxygen) to $+1050^{\circ}\text{F}$ (liquid bismuth). It can handle extremely high flow rates, too.

Fig. 1 — Schematic of
ultrasonic system for testing fluids.



is Ultrafast . . .

accurate and versatile

Calculations show that particle concentrations as high as 120,000 counts per 100-ml fluid sample, in 100% inspection, can be achieved. This requires a 30,000 cps pulse repetition rate, and a low fluid flow rate.

How It Works

The operation of this fluid testing device is based on the fact that a wave front travels through a homogeneous medium without reflection until a discontinuity or change in density is encountered. Such a discontinuity causes a fraction of the wave energy to be reflected in a secondary wave front, traveling in a direction opposite to the initial wave. The energy of this secondary wave is proportional to the size of the discontinuity.

In practice, a wave front is initiated by a short burst of ultrasonic energy introduced into the medium under test (hydraulic fluid) by a transducer acoustically coupled to the fluid. Various amounts of energy are reflected back toward the source as

discontinuities of different size and location are met by the wave. Finally, the remaining energy is reflected by the wall opposite the source. The initiating transducer also converts the reflected energy into electrical signals which are amplified and displayed on the vertical axis of a cathode ray tube. This sequence is repeated at a suitable periodic rate to present a continuous display. This searching operation is repeated at rates varying from 60 to 30,000 cps. This variation in search rates is required to accommodate a variety of flow rates.

The horizontal sweep circuit of the cathode ray tube can be adjusted to present the wave source as the origin, and the wave reflected from the wall opposite the source as the terminus of the horizontal axis. A cross-section of medium under examination is thus displayed. The distance on the horizontal axis between an intermediate reflection and the origin is proportional to the physical distance in the medium. The height of such a reflection on the vertical scale is a measure of the area that the discontinuity has presented to the wave front. Call-

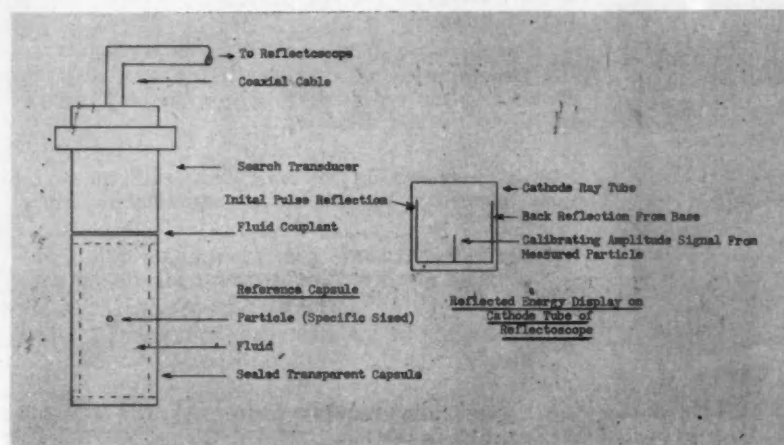


Fig. 2 — Calibration schematic.

Ultrasonic Fluid Inspection

... continued

bration is accomplished by the inspection of test fluids which contain particles of known size (Fig. 2).

In laboratory tests, a search unit (shown in Fig. 3) was designed and built. This unit was designed to allow both static and dynamic scanning of hydraulic fluid. The vertical scale of the tube display was calibrated by introducing particles of known size to the fluid. The electronic gates were calibrated for discrete band widths by the same method. During testing, contaminate particles are introduced to the fluid and the resulting reflected energy displays are measured, visually counted, and electronically counted on three standard electronic totalizing decade counters.

The basic components of this system have in the past been incorporated in commercially available equipment such as the Sperry UW reflectoscope (Fig. 4), which is at present used extensively for

ultrasonic examination of solid materials. In the inspection of solids, the search crystal is moved back and forth over the material until the total area has been surveyed.

The basic principle was modified with innovations which permit the equipment to be used to inspect a complete fluid system. In this development the crystal is stationary and the fluid is pumped past the crystal. Other modifications which make it possible to detect, size, and count particles include:

1. Establishment of an electronic gate of varying length and position within a test section. Signals from particles within this gate are sent to a discriminator unit and thence to electronic counters.

2. Electronic counters arranged so that each of them totalizes the particles in a predetermined band width (as 10-20 micron, 20-30 micron). All particles within the gate are counted.

3. Flowmeter installed in the system in order to eliminate multiple counts within the gate. This is necessary so that the repetitive pulse rate of the search crystal and the gate length may be adjusted to provide a sampling rate which is coordinated with the flow rate.

With this arrangement of gate, counters, and flowmeter it is possible to avoid duplicate counts for a single particle and yet insure that all particles will be counted. It should also be noted that the oscilloscope presents information on particle size, throughout the search unit length, both within and outside of the gate region.

Operational Qualification

In order to present to industry a reliable, precise, and rapid method of evaluation of fluids and filters, an operational qualification program for the ultrasonic method is underway. This program is designed to cover all the aspects of the system necessary to guarantee its performance and is divided into three major parts.

- Determination of the accuracy of the ultrasonic method by comparison with existing accepted quantitative methods and the development of a calibration standard.

- Development of a standard (or standards) of cleanliness for hydraulic fluids, applicable to counting by ultrasonic methods.

- Development of suitable test equipment for field inspection by ultrasonic methods, including:

1. Suitable hardware for retention or rapid coupling of a search unit to the hydraulic system.

2. Packaging of the electronic equipment for field use.

3. Establishing the procedure required for this method of testing.

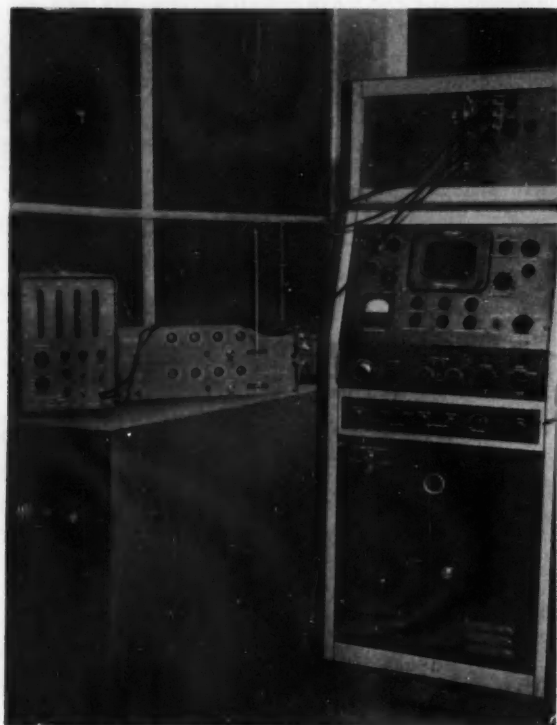


Fig. 3 — Experimental model of search unit.

The work involved in these three parts will be conducted simultaneously so that the ultrasonic inspection method may be ready for service use at the earliest possible time.

Application of the methods developed may easily be extended to fluids of a wide temperature range. The development of transducer crystals that will be compatible with the fluids involved and capable of withstanding thermal shock is all that is required and is already well along.

One of the past system qualification tests involved inspection of the various hydraulic systems of an S2F-1 aircraft. This complete inspection required only three quarters of an hour. Inspection with the patch system required three hours to obtain samples from each system, plus additional time for filtration and microscopic examination.

With the ultrasonic unit the aircraft's hydraulic systems fluid was circulated through the search unit installed in the return line of the ground support equipment hydraulic test rig. The unit discriminator was set to size and count three micron band widths of 20-30, 30-40, and above 40 microns. A fluid sample was obtained for correlation, filtered through a millipore filter, and microscopically analyzed. Correlation of ultrasonic particle sizing ability is nearly equal to a microscopic analysis, but shows superior particle count ability.

Similar tests will be made on additional Grumman aircraft in order to get the information necessary for setting up the hydraulic fluid cleanliness standard.

ANOTHER METHOD for automatically measuring contamination will be described in the Journal next month.

Applications

Initial applications have been in the aircraft field where familiarity with past practice has enabled realistic evaluation of the system. It can soon be used with liquid metal reactors and cryogenic fuels.

The speed and accuracy of ultrasonic inspection will make it particularly useful to industry . . . Diverse finished products—such as chemical solutions, lubricants, hydraulic fluids, and liquid fuels—can be continuously monitored. Search units (installed in fuel and hydraulic lines) combined with automatic counters and alarms will provide automatic warning of dangerously large particles in shipboard systems. The signal output of these sensing devices can also actuate automatic selector valves, causing the contaminated fluid to pass through additional filter stages.

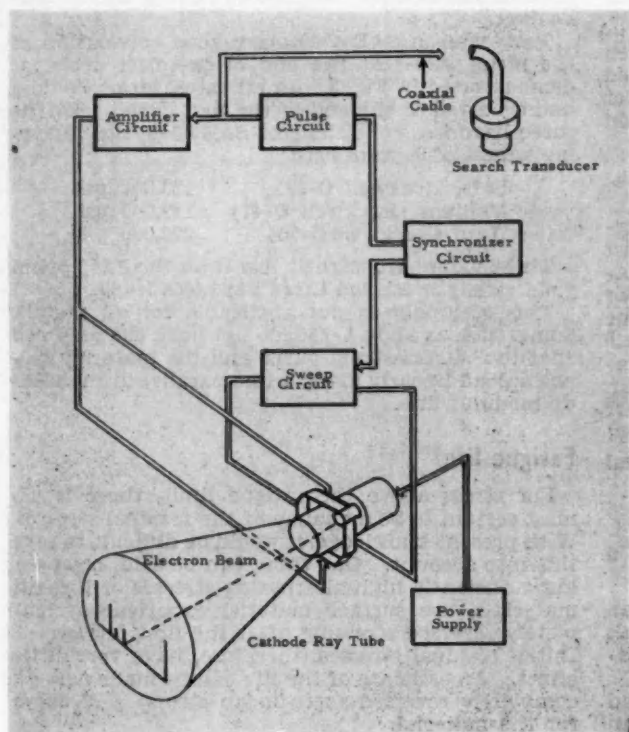


Fig. 4—Schematic function of reflectoscope.

Tips on Designing with Residual

Based on a report by

G. M. Sinclair and JoDean Morrow

University of Illinois,

and A. S. Ross

Boeing Airplane Co.

(Presented before Division IV of the SAE Iron and Steel Technical Committee)

TWO QUESTIONS that designers of fatigue loaded parts must answer are:

1. What is the fatigue limit?

2. If I exceed the fatigue limit, what is the fatigue life?

These questions are further complicated when there are residual stresses involved. Recent rapid testing techniques have produced guiding data for at least part of the answers to these questions, when residual stresses are present.

Estimating the Fatigue Limit of a Part

Residual stresses should be looked upon as a portion of the stresses that the surface material must resist. These stresses will not change in hard materials with moderately low residual stresses for amplitudes of alternating stresses near the fatigue limit. Even in a soft material, there will be little change when the member is stressed near the fatigue limit. Therefore, a reasonable estimate can be made of the fatigue limit of a member or part that has moderately low initial residual stresses by:

- Superimposing the *initial* surface residual stresses on the service stresses.
- Considering these stresses to remain unchanged during the fatigue loading.
- Treating the problem as any other in which a mean stress is present.

In solving a fatigue limit problem with a mean stress, it must be remembered that hard materials are more sensitive to mean stress than are soft materials. This characteristic is shown in Fig. 1.

When the initial residual stress is high or a load pattern is used that produces a stress greater than

the yield strength of the material, the problem breaks down into two parts. The first is to determine what happens during the first stress cycle and the second is to repeat the procedure used for the low residual stress case.

The yielding on the first cycle may be quite large. This results in a new mean stress, σ_1 , after the first cycle. From Fig. 2 it is seen that:

$$\sigma_1 = \sigma_y - \epsilon_a E = \sigma_y - \sigma_a$$

In this expression, ϵ_a is the amplitude of the alternating strain and $\sigma_a = \epsilon_a E$. With this new value of σ_1 , the fatigue limit is calculated, assuming the new residual stress does not change during the fatigue loading.

Tests run on SAE 4340 show good correlation of the mean stress at the end of the first cycle, as demonstrated in Fig. 3. In all cases, large yielding had occurred at the end of the first cycle. For the three hardness conditions of SAE 4340, the following values of σ_y were used:

Soft (Rockwell C-29)	123,000 psi
Medium (Rockwell C-41)	172,000 psi
Hard (Rockwell C-50)	222,000 psi

These values are slightly less than the 0.2% offset yield strength for the three hardness levels.

This technique is not applicable for all metals. Some, such as alloy A-286, do not have the assumed "flat top" stress-strain curve and the material may not unload linearly along a line parallel to the elastic modulus line.

Fatigue life

For stress above the fatigue limit, there is almost certain to be a change of the residual stresses. With present knowledge, it would be difficult to take this into account. One thing can be said, however. For sufficiently high alternating stresses or for soft materials, the surface material experiences completely reversed stressing after the first few cycles. Initial residual stresses, therefore, have very little effect. An estimate of the life can be made using a completely reversed (zero mean stress) *S-N* curve for the material.

Stresses

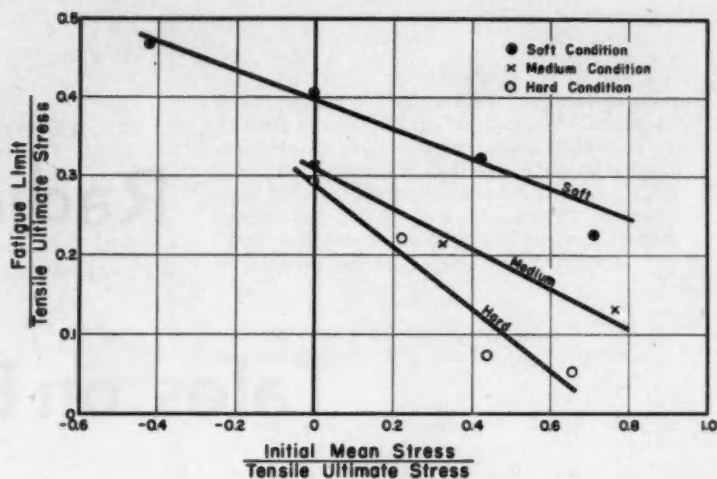


Fig. 1—Hard materials are more sensitive to mean stress than soft materials. The effect of initial mean stress on fatigue limit for three hardnesses of SAE 4340 is shown. The Rockwell C values for the three conditions are: 29, 41, and 50.

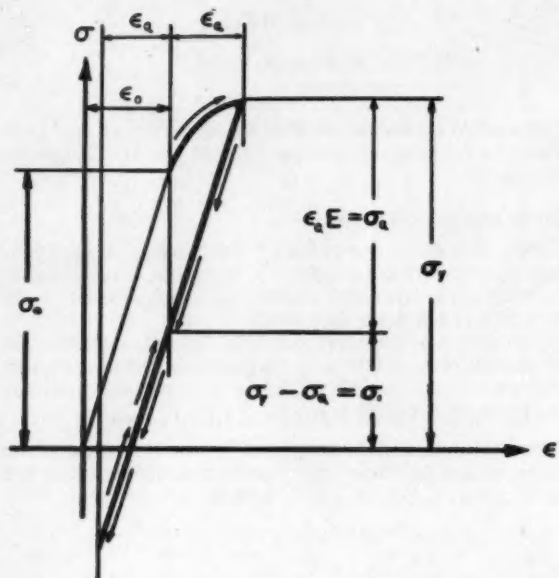


Fig. 2—Yielding on the first cycle of fatigue loading produces a new mean stress that can be used for fatigue limit calculations. A model for this yielding action is shown with σ_1 being the mean stress after the first cycle.

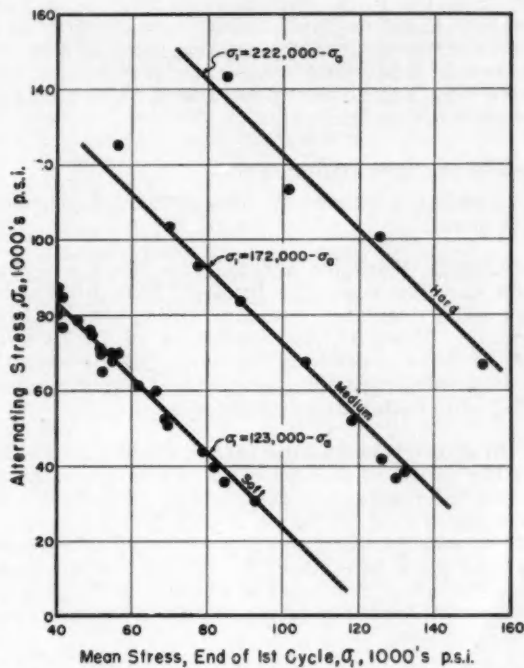


Fig. 3—Verification of the yielding model shown in Fig. 2 and its equation is found in data from all SAE 4340 specimens, which had large-scale yielding on the first cycle, is plotted on a mean stress versus alternating stress.

Radiotracers Tell Tales on Engine Wear

... how it is affected by oil detergency, filtration, and abrasives.

Based on paper by

Harry Halliwell

U. S. Naval Engineering Experiment Station

TESTS at the Naval Experimental Station on submarine diesel engines showed how filtration, oil detergency level, and abrasive particle size affected piston-ring wear. They were made in two parts: (a) with a clean engine oil system, and (b) with abrasive contaminants added.

Results of clean engine tests

Tables 1 and 2 show the detergency and filtration test results.

Additives Minimize Wear—The average chromium and iron wear rates for the different oils show that wear decreases with increasing amounts of additive. (Code A is a non-additive oil, Codes B, C, and D have increasing amounts of detergent.) Table 3 shows the relative effect of the detergent additive on both chrome and iron wear.

Filtration Prolongs Ring Life—Table 4 shows the relative effects of full-flow and bypass filters in removing the radioactive wear debris. Filtration prolongs piston-ring life for all oil detergent levels studied. Bypass filtration was slightly more effective in reducing wear rates than full-flow filtration when using the lower detergent level oils. Both types of filtration were equally effective for the higher detergent level oils.

A trend can be seen. . . . With increasing amounts of detergent, the relative effectiveness of the full-flow filters improves, and that of the bypass filters decreases.

Faces Wear Faster—Table 5 shows that the face wear (chrome) contributes 70% of the total piston-ring wear.

Dirty engine test results

Figs. 1-6 show the rates of wear debris accumulation during three periods: (1) baseline (no abrasive, no filter), (2) abrasive added, no filter, and (3) full-flow or bypass filter in circuit.

The effect of abrasive particle size was determined by the difference between the baseline wear rate and the wear rate produced after the contaminant is added to the crankcase.

Particle Size Affects Wear—The average wear rates (both chrome and iron) of all three oils for each abrasive size in 10^{-7} g/hr are:

Average particle size, micron		
22	15	5
1542	2302	1830

The 15-micron particles produced considerably more wear than the 5- and 22-micron sizes with all three oils.

Detergent Additives Double Wear—The average wear rates for each oil are:

Oil Code	Total Wear, 10^{-7} g/hr
A	1258
B	2015
D	2508

The two detergent additive oils (B and D) apparently dispersed all sizes of abrasive contaminant so that chrome and iron wear was twice that with the no-additive oil.

Filters Effective: Full-Flow Best—Filtration effects were measured by the difference between the

Table 1
Detergency and Filter Test Results
Chrome Wear

Oil Code	Chrome Wear Rate, 10^{-7} g/hr Filter System			
	None	Full Flow	Bypass	Average
A	260	249	158	222
B	225	204	196	208
C	142	112	118	124
D	42	34	35	37
Average	167	150	127	

Table 2
Detergency and Filter Test Results
Iron Wear

Oil Code	Iron Wear Rate, 10^{-7} g/hr Filter System			
	None	Full Flow	Bypass	Average
A	98	95	80	91
B	85	82	65	77
C	63	57	58	59
D	30	27	28	28
Average	69	65	58	

Table 3
Detergent Additive Level Effect on Wear

Oil	% Detergent (by Vol.)	Relative Wear, %		Total
		Chrome	Iron	
A	0	100	100	100
B	2	94	85	89
C	5	56	65	60
D	16	17	31	24

Table 4
Effect of Filtration Wear

Oil Code	Wear, Each Oil, % of that with no filter	
	Full-Flow Filter	Bypass Filter
A	96	67
B	92	84
C	82	86
D	85	88

THIS article describes how radiotracers were used to determine the effect of certain oil variables on engine wear. Next month B. A. Robbins, Enterprise Division, General Metals Corp.; P. L. Pinotti, Standard Oil Co. of California; and D. R. Jones, California Research Corp., will cover the effects of fuels on engine wear under different operating conditions.

Some details of the Experiment Station test methods described by Mr. Halliwell follow:

They were conducted in a General Motors 3-71 series diesel engine coupled to a 150-hp electric dynamometer. Chrome-plated piston rings were activated and placed in the second, third, and fourth piston grooves.

Standard engine operating conditions were: 67.5 bhp load, 1800 rpm, 200 F lube oil temperature, 170 F water jacket temperature, and oil flow rate of 0.5 ± 0.1 gpm through the scintillation counter well.

The detector was a Nuclear-Chicago DS-5 scintillation probe containing a 2-in. diameter by 2-in. high thallium-activated sodium iodide crystal.

Natural aluminum oxide abrasive compounds (with average particle size grades of 5, 15, and 22 microns in diameter) were used as contaminants. They were introduced into the crankcase at about 10 ppm of the total lube oil charge (by weight).

Excerpts are taken from discussions by the following: H. R. Jackson, Atlantic Refining Co.; R. J. Pocock, Ford Motor Co.; and G. C. Lawrance, Southwest Research Institute.

Table 5
Chrome versus Iron Wear

Type Wear	Average Wear Rates, 10^{-7} g/hr			% Total Wear
	None	Full Flow	Bypass	
Chrome	167	150	127	70
Iron	69	65	58	30

Tales on Engine Wear

... continued

rate of increase of wear debris in the oil after abrasive addition (the period 7-12 hr in Figs. 1-6), and the rate of change during the filtration period.

Table 6 shows the effect of particle size on filtration. The effect of oil detergency level on filtration is shown in Table 7.

These results show that both types of filters were effective in removing large amounts of wear debris generated by the abrasive contaminants. The differences in filtration effectiveness among the three abrasive particle sizes are not significant. However, the full-flow filters were superior to bypass filters in removing wear producing contaminants.

Detergency May Not Be Filter Factor — No trend was established that would show filter effectiveness reduced with high detergent additive level oils. From Table 7 it might seem that using filters with Code B oil is less effective than with Codes A or D. But, because the filtration effectiveness was the same for Codes A and D, oil detergency

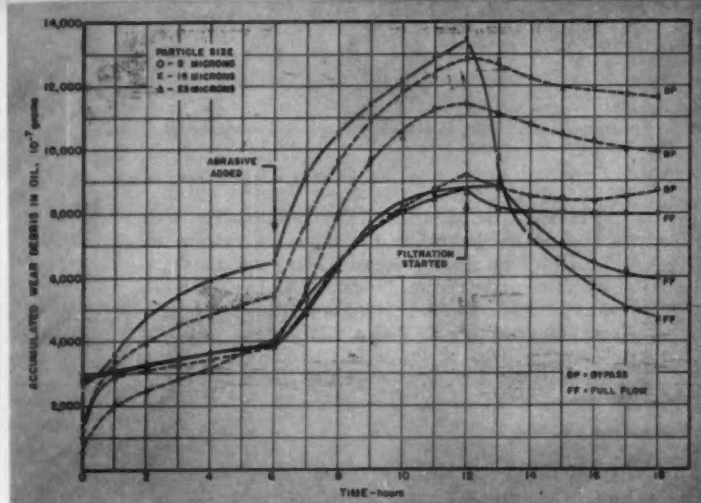


Fig. 1 — Chrome wear debris in Code A oil.

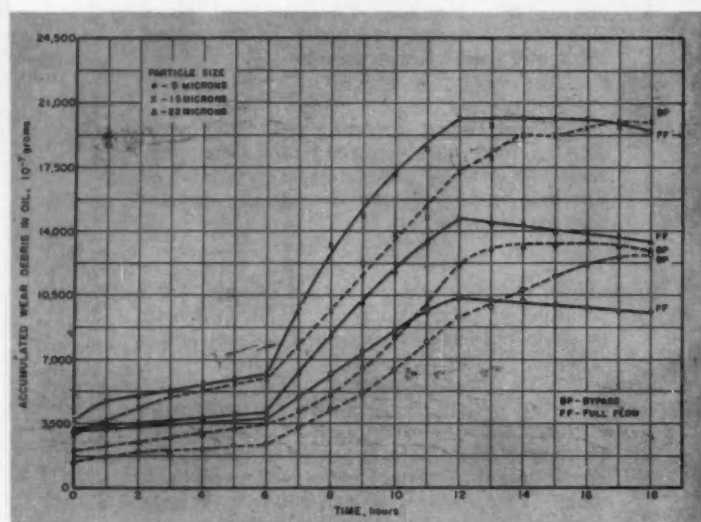


Fig. 2 — Chrome wear debris in Code B oil.

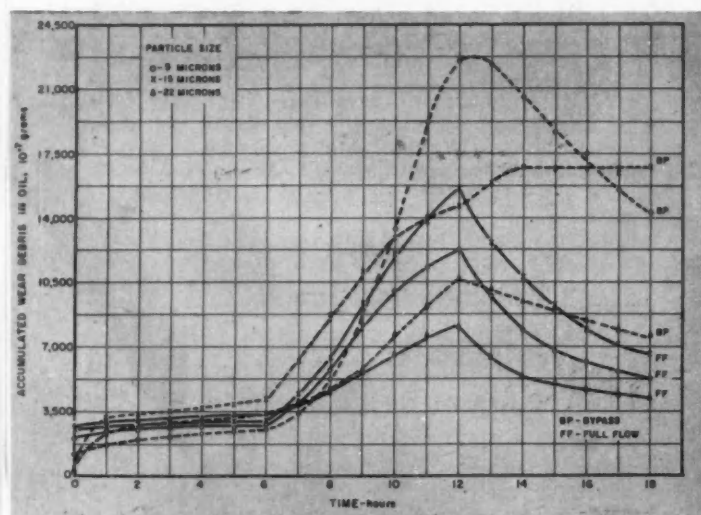


Fig. 3 — Chrome wear debris in Code D oil.

Table 6
Effect of Abrasive Particle Size on Filtration (Rate of debris removed to that generated, %)

	Abrasive Particle Size		
	22 Microns	15 Microns	5 Microns
Full Flow Filter	138	149	137
Bypass Filter	122	86	116
Average	130	118	127

Table 7
Effect of Oil Detergency Level on Filtration

Averaged for all abrasive particle sizes, and measured as rate of debris removed to that generated, %.

Oil Code	Filter Type		Average
	Full Flow	Bypass	
A	178	119	149
B	111	68	90
D	157	127	142
Average	149	105	

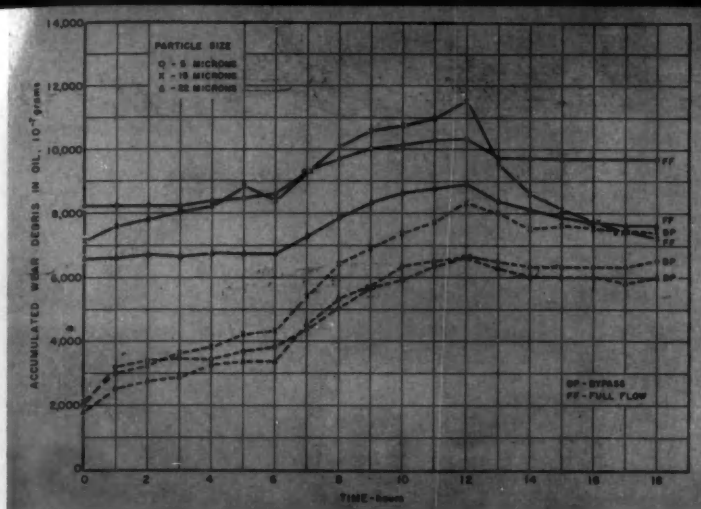


Fig. 4—Iron wear debris in Code A oil.

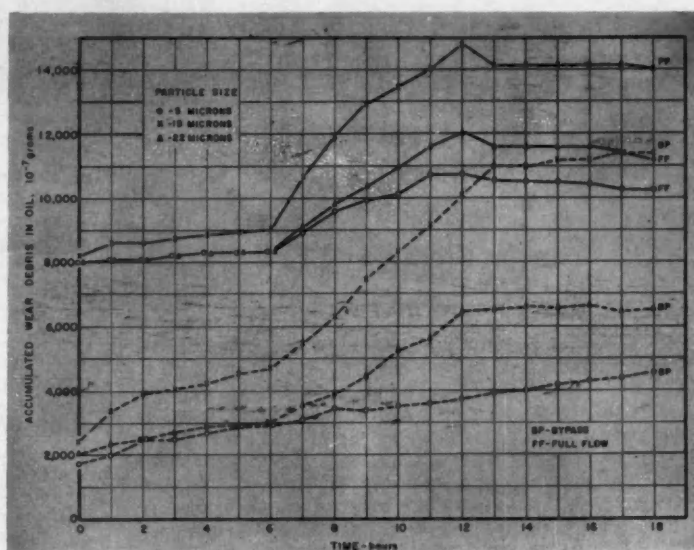


Fig. 5—Iron wear debris in Code B oil.

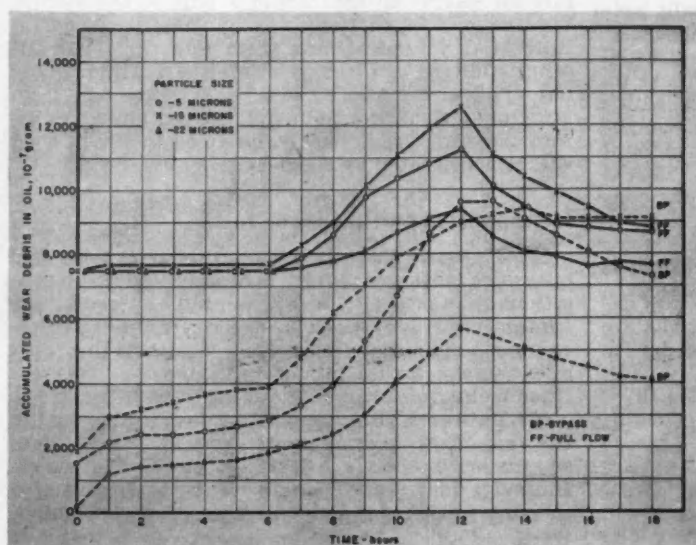


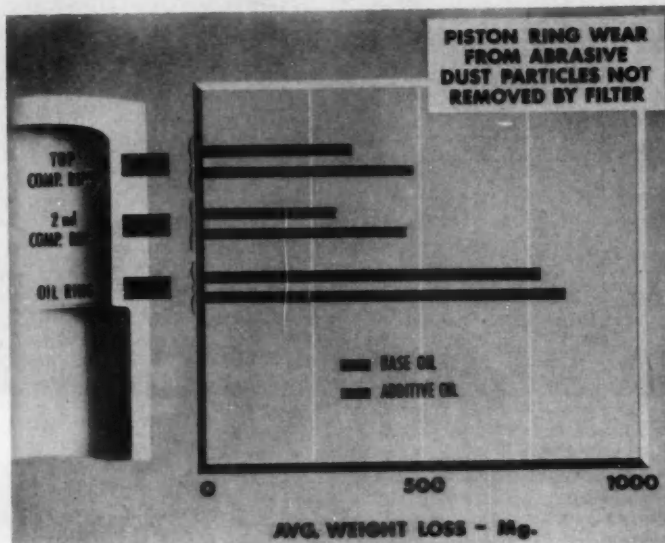
Fig. 6—Iron wear debris in Code D oil.

Radiotracers Tell

Tales on Engine Wear

... continued

Fig. 7



may not prevent filters from removing wear debris from engine oil systems.

Excerpts from Discussion

Results of Ford abrasive wear tests

Mr. Pocock: I would like to show you the results of some laboratory engine tests that were made on a Ford, valve-in-head, 6-cyl engine, which was operated at 3800 rpm at three-quarter load for 20 hr, with abrasive dust added directly to the crankcase. Fig. 7 shows the wear of the piston rings by the abrasive particles that were suspended in the oil, passed through a full-flow filter, and were thrown upon the cylinder walls from the crankshaft and the connecting-rod squirt holes. The wear pattern shows the sensitivity of the oil ring to the contaminant in the crankcase oil. Fig. 8 shows the severity of the wear on the engine bearings and most dramatically evidences the difference in concentration of dust that had been carried through the filter when additive oil had been used as compared to results of a base oil test. Fig. 9 is a summary of the test results, which illustrates the fact that not all areas and components of an engine will react the same to the amount of contaminant carried in the engine oil. This is also true of the effect determined for various contaminant particle size ranges.

Dirty engine filtration complicated by detergents

Mr. Pocock: Mr. Halliwell states that "As the detergency levels of diesel-engine lubricating oils are increased, piston-ring wear rates were reduced, with or without oil filtration." Let us examine the test results once more, assuming that the test of each oil type in the clean engine tests was not influenced by any foreign contaminant. The wear of the piston rings occurred during rubbing contact with the walls of the cylinders and the ring grooves. Some wear debris was generated and continued to circulate in the oil. The filters removed some of the particles

and, no matter how few were retained, in an absolute condition only a reduction in wear could occur. The reduced wear observed in the tests without filters shows that as the detergent additive level was increased the wear rate decreased, demonstrating increased slipperiness or load carrying capacity of the inhibited oil film. The results were fewer metal-to-metal contacts between ring and bores. If the experience in engine service stopped here, the conclusion that increased detergent oil additive levels decrease piston-ring wear would be true.

Unfortunately, engines do not operate under relatively clean conditions in the majority of service applications, and therefore it must be emphasized that the use of effective filter media to remove dirt as rapidly as possible is ever increasingly important. The trend towards increasing the additive content of oils continues as the more beneficial effects of these compounds are found to be able to offset some inferior quality in the fuel or a part of the engine. We must not be carried away by these localized results. Can we not achieve them with the use of another additive, in place of a detergent, which would not so adversely affect the filter system. The filter is trying to clean the oil of rubbish and abrasives before they are circulated to the areas in which wear will be accelerated by the debris.

Is suspension sufficient for tests?

Mr. Jackson: We sincerely question that detergent oils cause more wear under contaminated sump conditions than base oil. If detergent oils suspend more contaminant than base oils, would they not by inference suspend more radioactive wear debris than base oils, thereby giving higher indicated wear via the trace technique, even at the same true wear rate?

Mr. Halliwell: It is agreed that, for reliable results, the radiotracer technique depends on the constant suspension of the wear debris in the lubricating oil. However, during our base oil tests, rigid monitoring schedules did not indicate any significant sedimentation.

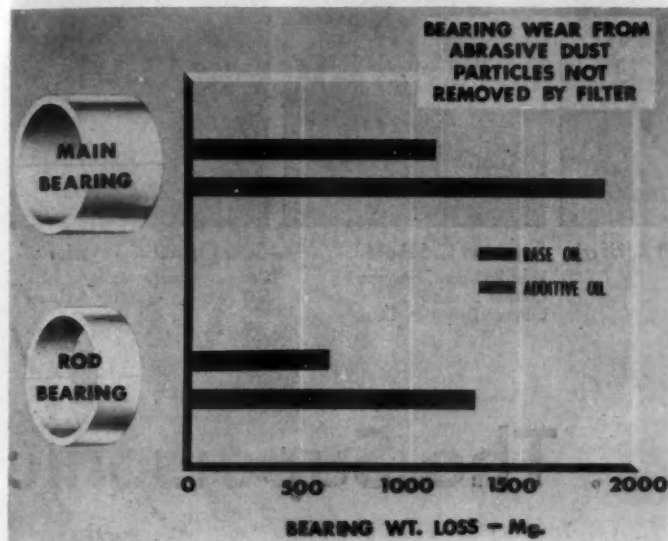


Fig. 8

Filtration data shows relative effectiveness

Mr. Jackson: Mr. Halliwell states that the full-flow filtration was superior to the bypass filtration in reducing the contamination and attendant engine wear. On what data was this conclusion based? No actual contaminant removal rates were measured, and of course, once the oil filters were cut into the circuit, no meaningful wear rates could be obtained. Only if the radioactive wear debris has the same particle size as the contaminant could the author infer contaminant removal efficiencies.

Mr. Halliwell: It is apparent, from the slopes of the curves for the 12-18-hr test period in Figs. 1-6 that the full-flow filters were, on the average, more effective than bypass filters in removing radioactive piston-ring wear debris. These data were intended only to show the relative effectiveness of the two filter types in removing radioactive piston-ring wear debris produced as a result of the abrasive action of the three size grades of abrasive; therefore, no attempt was made to measure actual contaminant removal rates. Since the abrasive contaminant was not radioactive, we could not discriminate by radioactive means between the particle sizes trapped by the filter.

SwRI tests show more face wear

Mr. Lawrason: The percentage of total ring weight loss in the GM 3-71 engine that was attributable to other than face wear was much less in the work at SwRI than the 30% that the author found. . . . It would appear that fuel sulfur content may be responsible for an increased ratio of face-to-side wear, and most of the work at SwRI was done with 1% sulfur content fuel. Since the cylinder liner is largely affected by increased fuel sulfur content, it would appear that the face-side wear ratio might be higher. At any rate, several careful spectroanalyses of the drain oils at SwRI indicated no measurable ring wear debris other than chrome from the face. This fact was confirmed by measuring the hot rings.

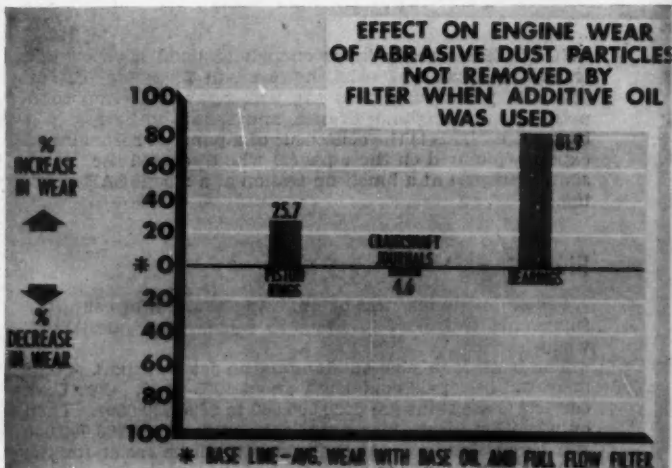


Fig. 9

Mr. Halliwell: It is probable that the SwRI tests, in which the top ring only was radioactivated, reflected fuel effects to some extent. The Experiment Station results probably were more related to lubricants effects.

Why wear doesn't vary with particle size

Mr. Lawrason: First of all, the same quantity of each size abrasive was introduced every time. In the case of the 22-micron particles, a larger percentage would tend to be centrifuged out of the oil system or hang up in fitting joints so that they cannot reach the piston rings; however, relatively few 22-micron particles need reach the ring belt to cause severe damage. Conversely, in the case of the 5-micron particles, distribution should be relatively better in the oil system and more of these particles would tend to reach the ring belt.

▶ To Order Paper No. 72T . . .
... on which this article is based, turn to page 6.

aeronautical

experts

discuss

The Supersonic



Brig. Gen. Harold R. Harris
(USAF, Ret.)
President,
Financial Services, Inc.



Raymond C. Sebold
Vice President, Engineering
Convair Division
General Dynamics Corp.



Gen. Claude J. Teyssier
General Representative,
Sud Aviation in North America

ENGINEERS already know enough to build a supersonic transport. Problems exist, however, in financing, design, production, and airport-to-city transportation. And competition from England, France, and Russia to be first will be intense. This is the consensus of a panel of aeronautical experts (pictured on these pages) who discussed the supersonic transport at a luncheon session of a recent SAE meeting.

Financing

People in the business of financing aviation are sure the supersonic transport is going to come. The question is when.

The bank loan now outstanding on jet transport equipment will be repaid completely about 1965-1966. (For U. S. carriers these loans are \$400,000,000 to \$600,000,000). Then only the long-term insurance loans of around \$800,000,000 will be outstanding. At that time it will be easier for the airlines to get funds to buy a fleet of supersonic aircraft.

Unit cost of the supersonic transport will be around \$20,000,000. It will cost about \$200,000,000 to develop it. But, the supersonic transport, may turn out to be competitive costwise with the subsonic transport.

Design and Production

Sooner or later airliners will fly hypersonically — that is at Mach 5 or faster. At Mach 5 structure temperature will approach 2000 F. Pressure control, and noise problems will also be severe. These must be solved in ways that do not put undue economic penalty on the airlines.

There is too much glib agreement among airplane designers on what the supersonic transport will be like. It would be a healthier situation if at this stage of the game several companies were designing several different concepts. Right now there are several companies interested in the supersonic transport and they seem to agree that it will be a Mach 5 vehicle weighing about 500,000 lb. It may be atomically powered. And, it probably will be equal in carrying capacity to about 12 DC-7's or 3 707's.

One experienced observer predicts operation of the supersonic transport in regular scheduled service in about 15 yr. This vehicle probably will be the result of an orderly extension of earlier design. No one organization can risk bringing out a supersonic airplane full of new features.

City-Airport Travel

The long-range supersonic flight will have to be supplemented by a faster way of getting the passenger from city center to airport. The airports for the supersonic transport may very well be even farther from the city center than they are now. Some kind of vertical-flight, short-range air vehicle looks to be very much a part of the era of supersonic transports.

Foreign Competition

The United States will not necessarily be the first country to produce a supersonic transport. England, France, or Russia might develop one first.

The British are, of course, very much interested in the supersonic transport. It is likely that the British effort will involve:

1. Cooperative effort on the part of various British aircraft builders to outline the requirements for the supersonic transport.
2. Law-of-the-jungle design competition of the transport.
3. Selection of one or two companies or combinations of companies to build the transport.

The supersonic transport or transports are expected to be ready for certification in the early 1970's.

The French, too, are interested in the supersonic airplane. Because of the French aircraft industry's relatively small size, the French approach has been to study world aviation needs and to develop aircraft to meet the needs that other builders aren't already meeting. For example, the French are trying, via the Caravelle, to bring jet flying to cities where others aren't doing it.

It is conceivable that the French might study the question of how to make a short-range supersonic transport. Sud Aviation has two teams engaged in paper work relating to the problems of supersonic transports.

We may see an accelerated development of an integrated European industrial complex. Maybe the British and French aircraft builders will join in projects such as the supersonic transport.

One thing is certain. The supersonic transport will require a number of breakthroughs in human physiology. We cannot change people to fit the aircraft. We are going to have to find out more about people in order to fit the aircraft to them.



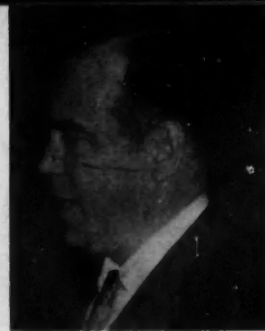
William Littlewood
Vice President — Research
American Airlines, Inc.



Robert L. Cummings, Jr.
President,
New York Airways, Inc.



Christopher Clarkson
U. S. Representative,
Vickers-Armstrongs (Aircraft) Ltd.
Director,
Vickers-Armstrongs, Inc.



Ansel E. Talbert
Vice President,
Flight Safety Foundation, Inc.

Transport

AVIATION PRESS QUERIES THE EXPERTS

The aviation press questioned the aviation experts on the supersonic transport at the conclusion of their formal presentations. Representing the press were: Mary Hornaday, *Christian Science Monitor*; Richard Witkin, *New York Times*; George Carroll, *New York Journal American*; and Edwin Pipp, *Detroit News*. Following are the questions and answers.

What about fares and stewardesses?

Littlewood: The airlines will certainly try to hold the line on prices. Our goal will be as it always has been, better service at the same fare or a very small increment. We will certainly continue to stress speed, comfort, and safety. One factor which may contribute to low fares will be new fuels containing more energy per unit of fuel. These fuels would save weight, which would help greatly in keeping down costs.

You can assume that as long as the airlines are stressing comfort, there will be stewardesses.

Do the Russians have a large supersonic airplane for use as a bomber or a transport?

Sebold: The Russians keep surprising us. It may be that they are well along on the supersonic transport.

Will the supersonic transport have VTOL capabilities by 1970?

Sebold: I predict that the supersonic transport of 1970 will not have VTOL capabilities. We would, of course, benefit if we could give the large supersonic airplane VTOL characteristics because it would lessen the noise problem. The airplane could rise vertically to great heights almost directly over the airport. This would alleviate the problem of the loud noise we hear on the ground in the wake of the supersonic transport.

It may be that the supersonic transport will have to climb at subsonic speeds all the way to the 35,000 foot altitude unless it climbs over water.

How will you speed up the loading of passengers into the

supersonic aircraft in order to keep it flying and earning money as much of the time as possible?

Sebold: You're right in assuming that utilization of the transport is extremely important. The airplane will have to be utilized at least 8 hr a day. We will have to find ways to speed up the on-the-ground portions of the cycle. We cannot just tell people to work faster in loading the plane or to walk faster in boarding it. We must design into the plane faster means for loading passengers and cargo. There are other things we can do too, to speed up servicing and maintenance of the airplane. We probably won't be able to wait for a failure to occur and then take care of it on the ground. We may find that we have to do our maintenance on the basis of knowing what is happening to all the major components of the airplane so that even before it lands, its servicing and maintenance needs are known, and the ground crew is ready to take care of them.

Will the supersonic transport have windows?

Sebold: Maybe not. Windows are very costly weightwise. Pressurization for extremely high altitudes must be 100% reliable. Windows will make this reliability harder to achieve.

Littlewood: One element in the transportation picture that doesn't change is the human element, the passenger. We must accommodate the airplane to the passenger. It may be convenient for the designer to consider a take-off climb angle of 25 deg in order to get the noisy airplane high above the ground fast, but the passenger won't tolerate a take-off at a 25 deg angle.

Present aircraft are pressurized to about 8000 ft apparent cabin altitude. The supersonic transport, although it may cruise at 80,000 ft, may not have such a high cabin altitude simply because the passenger will not tolerate a rapid change in pressure from the pressurization at cruise altitude to sea level conditions on landing. Either we will have to keep cabin altitudes lower or we will have to suffer penalties of slower rates of airplane climb and landing. **Sebold:** That's right. We may find it necessary to maintain the cabin at sea level pressure all the time.

How is the development cost of these supersonic transports to be absorbed?

Harris: Historically, commercial operators have always benefited from development paid for by the military. With the supersonic transport the major development behind the engine, fuel, and airframe will be dependent on work done and paid for by the military. Some people who have studied the situation say that in the 1970's the air traffic of the whole world would require only 100 supersonic transports. If the development costs of the supersonic transports were to be spread over only 100 units, commercial operators could not afford the supersonic transport.

Sebold: Some air transport experts say 35 supersonic transports, each accommodating 135 passengers, could carry all the traffic over the North Atlantic.

Engineering Educators Must Develop Men Who Will Put Atom to Work Constructively

H. J. Gomberg

Professor and Chairman of Nuclear Engineering Department
University of Michigan



WHAT the field of nuclear engineering needs are men who understand the nature of the nucleus as a source of energy and the nature and characteristics of that energy, and who are motivated to find employment for it in constructive and economic ways.

This is engineering at its very best — and for the time being, this is really the only kind that we can afford. At this stage, education must make whatever contribution it can to find the men capable of doing this type of work and providing them with the tools and understanding necessary to do so.

Educator Must See Future

One of the major challenges to the engineering educator is anticipation of new developments so that he may direct advanced student interests into fields of greatest potential productivity. Guide lines for such decisions are often apparent in new developments in the basic sciences, in changes in the technology, and in altering and evolving economic relationships. In this sense, the nuclear energy field is no different from any other. However, two major ingredients are lacking.

The first is extensive engineering experience backed up by years of operational data; the other is the failure, to date, to achieve significant economic success. In relating such performance to the demands made within the automotive industry, one is impelled to ask questions about pursuit of the nuclear field, and certainly about education for more men, with a view to having them swell the ranks. One obvious answer is that the greatest need at this time is the infusion of new ideas and new thinking to meet the challenges presented by atomic energy.

In areas where noncivilian economics apply, namely the military field, nuclear energy has met with phenomenal and spectacular success. The nature of weapons has changed completely and the nature of tactics and strategy has changed with it. At the moment any proposal to build a vessel for naval purposes which is not nuclear powered meets with suspicion and careful scrutiny. But the economics of even the very large oil tankers do not yet permit the luxury of nuclear propulsion. It is this gap that we are waiting to bridge. The need is for

more thorough-going research, more daring development, more complete understanding of the nature of nuclear energy so that it may be employed in manners compatible with its characteristics and which will serve real social and economic functions.

We start from the premise that nuclear energy is now available to man as a vast new resource in nature. The statistics vary, but we know that in the fission fuels alone we have roughly 20 times the heat power available from the fossil fuels, using the demonstrated technique of breeding. Should fusion ever be brought under control, the total energy supply would become indeed difficult to contemplate. Temperatures up in the millions of degrees are available, should we wish to make use of them. High-energy radiation, which would be enormously expensive to generate, is provided almost as a byproduct of the fission and fusion processes.

Radiation Now Wasted

Yet, at the present time, we take this high-energy radiation and convert it to heat in shields because at the moment we don't know what else to do with it. From this vast new source of energy, we do not as yet have competitive power in any form, either as electricity or as heat. No mass use for radiation has yet been found which is of any real significance within the economy. Even in the isotope area, where claims for savings up to several hundreds of millions of dollars have been made, the fact remains that there is disappointingly little industrial support for work in that field.

Despite this rather discouraging state of affairs as it exists at the moment, there are very few, if any, who have studied the nuclear field and feel that at sometime in the future nuclear energy will not become a dominant factor in the economy. The question is: when, and under what conditions?

The search is for new techniques, new products, new processes; in short, new ideas. What must emerge are either products or services which were not available in the past and are possible only through the medium of nuclear energy or old familiar products manufactured at lower cost than in the past. The first, of course, is the more exciting, but actually the second

has received most of the attention.

In training men for the nuclear energy field, it is not particularly important to imbue them with the importance of what has been done up to the present time, or the details of the processes that are now available, nor spend a lot of time on the manufacturing or processing techniques that are now in use. These are useful only to the extent that they illustrate principles of science, but are to be avoided assiduously in discussing economical engineering techniques. However, through the contemplation of the fundamentals of the problem, new ideas are bound to emerge, particularly when worked on by well trained and reasonably creative people. It is these new ideas which will shape the nature of the field in the future.

If I could foretell now precisely what the nature of these developments would be it is obvious that I would not be writing this article, but would be busily writing patent applications. However, there are certain signs that indicate the shape of things to come. There is the recent ingenious and most encouraging combination of thermo-electric effects with fission as a source of heat. It turns out that uranium carbide can be made into a stable and very efficient thermionic emitter and that the heat source necessary for this emission can be provided by fission of the uranium itself. Thus, very compact and reasonably efficient high-output electric sources appear to be coming in the immediate future. They will take a form that will be completely different from any of the common electrical generating systems which we have used in the past and which up to now have been imitated in trying to employ nuclear energy.

Similarly in the field of radiation, the processes are of the shotgun nature in which the energy is largely degraded and where many of the effects are relatively easily duplicated by the employment of such old agents as heat and pressure. However, there is reason to believe that there may be catalytic phenomena dependent on specific resonance levels within atomic structure which can be reached only through the use of higher energy radiation, particularly, in the x-ray region. If this is true and we can make use of singular resonance phenomena where a small amount of energy creates a very large effect, we are moving into areas of significant advance, tailored specifically to take advantage of the characteristics of the high-energy radiation.

In the biological field, it has been possible to produce alterations in life forms and interference with life cycles of parasitic organisms in a manner which cannot be approached, let alone duplicated, by the use of chemical or physical means. Very small amounts of energy may be needed to produce results which, in their economic and social impact, may transcend many of the major energy developments.

Hypersonic Plane Design Influenced by New Concepts

Based on report by secretary

J. S. SOHN, Curtiss-Wright Corp.

AIRFRAMES are needed to operate at skin temperatures of 1800 to 2500 F for three to four hours at a time. To achieve these airframes a more balanced effort is needed between the development of new materials and the development, led by the designers, of new methods of utilizing present materials.

Two facts dominate the possible structures which may be used:

1. The hypersonic planes won't spend more than five minutes of their total life at the highest stress.
2. The low aspect ratio delta wings used result in very low structural loadings. Also, they can't maneuver much.

Thus, a design is limited by how thin the structure can be made, not how strong. In addition, the design will completely separate the high temperature resisting portions from the load carrying portions. This dictates the use of composite structures.

The most promising design, as an alternate to developing ultra new materials, would use:

1. A radiative outer layer of a refractory metal.
2. A conventional material load structure.
3. Protection of the load structure by an insulating layer.
4. A supplemental cooling system to handle the heat leak inward and keep the load structure and pilot cool.

This would present the lightest design except for a few applications of very short flight times. For these latter types, heat sinks, ablation, or liquid cooling by evaporation or transpiration would be necessary, that is, absorptive cooling.

The glide plane application remains an exception to either of the above types in that the wing leading edge conditions combine the problems of the hypersonic three-to-four-hour flight plane with the problems of the short flight time vehicles which can absorb a heat flow that, unabsorbed, would create a temperature of 10,000 F. Specifically the leading edge of glide bombers must operate continuously at 3000 F plus and have permanency and reusability. No present solution to this problem exists.

Serving on the panel which developed the information in this article, in addition to the panel secretary, were: **Herman Hanink**, Curtiss-Wright Corp.; **William Bruckart**, Universal Cylcop Steel Corp.; **Howard Burns**, Thiokol Chemical Corp.; **Wilfred Dukes**, Bell

Aircraft Corp.; **A. Kastelewitz**, Republic Aviation Corp.; **L. E. Laux**, The Martin Co.; and **John Maranchik, Jr.**, Metcut Research Associates, Inc.

(This article is based on a secretary's report of a production panel entitled "Fabricating Ultra High Strength and Refractory Materials." This report — along with 8 other secretaries' reports on various production subjects — is available in multilith form as SP-327. See order blank on p. 6.)

Integrated Shields Meet New PTO Standard

Based on paper by

Roy E. Harrington and
C. S. Morrison, Deere & Co.

INTEGRATED rotating shields for agricultural power takeoff drives — introduced several years ago — will comply with a revised SAE-ASAE standard to be published in 1960. The revised standard will provide that the PTO drive shall be integral with and journaled on the rotating members.

These integrated shields — also known as tubular or spinner shields — are used on both fixed length and telescoping PTO hookups on both integral and drawn implements. The shield is journaled on and normally rotates with the PTO hookup. It stops when contacted by the operator or his clothing. The shield remains with the PTO hookup at all times and thus requires no separate operation when being attached to or detached from the tractor.

Ball bearings, roller bearings and nylon plain bearings each are being used in these integral rotating shields.

Experience with integral rotating shields has revealed certain desirable design requirements for adequate shielding. The flared end of the shield, for example, should extend to or near the universal joint cross to protect the joints properly under both the tractor and implement master shields. Also, flared ends that adequately shield the joints must be rather large inside to permit sharp turns at each joint.

Some implements require 50 to 60-deg flexibility in the front joint. This clearance angle problem is greater at 1000 rpm than at 540 rpm because the new standard specifies a locking means 0.5 in. closer to the joint cross. The flared end should be sufficiently strong to resist denting when dropped on the implement tongue. Both it and the bearings must withstand a reasonable amount of abuse by the operator who is attaching or detaching from a damaged or dirty PTO shaft.

A support for the integral rotating shield reduces the possibility of damage during storage or when transported without the PTO hookup attached. Telescoping problems caused by dent-

ing of the tubes can best be met by adequate wall thickness and ample clearances for slight dents. The lap tubes should be generous to reduce vibration, noise, and wear.

To Order Paper No. 95W . . .
on which this article is based, see p. 6.

New Valves Designed for Missile Erector System

Based on paper by

G. DUANE SHAW, Rucker Co.

(Presented before the South Bay Division of
SAE Northern California Section)

SPECIAL main counterbalance valves have been designed for the Polaris missile erector system. Standard industrial or aircraft counterbalance valves are too abrupt in their control due to the fact that the valve spool will move from a fully open to fully closed position too rapidly, or the amount of linear spool travel between the two positions is too small, or both.

The new valves function in the same manner as the standard valves with the following exceptions:

1. A special valve spool is used, so designed that it has to travel a long distance linearly between the fully closed and fully open position. And since the standard tapered spool configuration provides extremely poor control, from the hydraulic standpoint, between fully closed and low metered flow, use is made of a hollow spool with oil metering controlled by a series of small holes drilled in a spiral pattern through to the center. With proper linear spacing of the holes, it is possible to get a straight-line variation of area available for oil flow as related to spool displacement.

2. Linear velocity of the spool travel is controlled. To augment the superior metering characteristics by the hollow spool, the spool shift is carefully controlled by means of a throttling orifice and a pilot control head. This, coupled with the larger basic spool diameter gained by the hollow spool design, provides excellent damping control over linear spool movement. The movement can be varied over a considerable range to provide adjustment of spool travel from relatively rapid to extremely slow total traverse.

These valves afford control of the erector arm and provide pressure control for the safety counterbalance valves. If a fluid line or one of the main counterbalance valves fails, the pair of safety counterbalance valves involved at the moment would provide emergency stopping of the cycle.

To Order Paper No. S200 . . .
on which this article is based, see p. 6.

Storable Propellants

Matched to Missile Needs

Based on paper by

J. Silverman and S. A. Greene

Rocketdyne, Division of North American Aviation, Inc.

NO single oxidizer or fuel exists which combines all the desired attributes of an ideal propellant. So each missile system must dictate its own set of propellant properties as well as their order of importance.

For example, maximization of specific impulse is increasingly important as the missile range increases—while less importance is placed on density and low freezing point. On the other hand, density impulse and wide liquidus range are important in short-range missiles geared to high mobility prior to launching.

The characteristics of storable oxidizers and fuels as they relate to these needs must be analyzed.

Storable Oxidizers (See Table 1 for physical properties.)

Nitric Acids—Modified nitric acids have been the most widely used storable oxidizers. Modification is necessary because pure anhydrous nitric acid (WFNA) isn't suitable for storage—it corrodes aluminum and steel alloys, and is thermodynamically unstable.

Since corrosion will limit acceptable storage life, it has been eliminated for some alloys by adding 0.5%-by-weight HF to the acid (called "inhibited" nitric acid). The container walls are thus passivated by a metallic fluoride coating. However, even inhibited acid cannot be stored indefinitely in many tanks of steel or other alloys which have high strength-to-weight ratios.

Because nitric acid is unstable, it slowly decomposes to yield oxygen, nitrogen dioxide (nitric oxide or NO), and water. Therefore, in sealed storage, there will be an excessive equilibrium pressure—primarily due to the oxygen component. So, operational acid mixtures contain approximately 3% water and 15%-by-weight of nitrogen dioxide in order to suppress high oxygen equilibrium partial pressure by a mass action effect.

Inhibited red fuming nitric acid (IRFNA)—whose red color comes from nitrogen dioxide—is the standard oxide used in current liquid-propellant missiles. Its advantages are very low cost, excellent availability, high density, and good physical properties over extended temperature ranges. It also meets ground stor-

Table 1 — Physical Properties^a of Selected Oxidizers

	WFNA	IRFNA	N ₂ O ₄	MON ^b 70/30	95% H ₂ O ₂	ClF ₃
Boiling Point, F	190	150	70.1	-4	294	53.2
Freezing Point, F	-52	-57	11.8	-112	21.9	-105.4
Density, gm/ml	1.50	1.57	1.45	1.37	1.42	1.83
Viscosity, cs	0.54	0.89	0.31	—	0.885	0.238
Vapor Pressure, psia	0.83	2.5	14.0	87	0.032	20.57
Heat Capacity, Btu/lb-F	0.42	0.39	0.75	—	0.643	0.40

^a At 68 F.

^b Mixed oxides of nitrogen.

Table 2 — Physical Properties^a of Selected Fuels

	RP-1 JP-4, 5	Hydyne	UDMH	N ₂ H ₄
Boiling Point, F	350-500	140-400	146	236
Freezing Point, F	-58	-65	-71	35
Density, g/ml	0.81	0.86	0.79	1.01
Viscosity, cs	2.5	1.45	0.71	0.96
Vapor Pressure, psia	0	2.49	2.3	0.20
Heat Capacity Btu/lb-F	0.45	0.65	0.65	0.74

^a At 68 F.

Table 3 — Performance^a of Fuels with IRFNA

Fuel	WMR ^b	d	I _s	I _e
RP-1	4.80	1.35	362	268
Hydyne	3.11	1.31	358	273
UDMH	2.99	1.26	348	276
50% UDMH- 50% N ₂ H ₄	2.20	1.27	354	279
N ₂ H ₄	1.47	1.28	362	283

^a 1000 psia, shifting equilibrium, sea-level optimum expansion.

^b Weight-mixture ratio

ability requirements. The main disadvantage is its modest performance.

Oxide of Nitrogen—Nitrogen dioxide performs better than the nitric acids. And it permits use of a wide variety of metallic construction materials (including high-strength mild steel).

Another oxide of nitrogen—nitrogen tetroxide (N₂O₄)—is low cost, has good density, easy availability, good materials compatibility, and high performance. But it has an extremely narrow liquidus range.

However, adding NO to N₂O₄ can depress the latter's freezing point. It will also increase specific impulse, although density impulse is decreased.

Hydrogen Peroxide—This oxidizer

has a high freezing point, which severely limits its operational range. More serious—peroxide decomposes slowly during storage, yielding water and oxygen. However, if the tanks are vented, it can be stored for over a year with negligible decomposition.

Chlorine Trifluoride—This unusually dense and vigorous oxidizer is a leading candidate for future exploitation. It delivers a specific impulse identical with nitrogen tetroxide—and the overall propellant bulk density is increased by approximately 15%.

A disadvantage of ClF₃ is that the system operates at somewhat higher oxidizer-to-fuel mixture ratios than the corresponding oxygen-based systems—hence less fuel is available for

regenerative cooling. In addition, chamber temperatures are about 100 F higher than with oxygen-based systems, exposing the coolant fuels to large thermal stress. However, ClF_3 may also prove suitable for use as a coolant, since it is stable and has fairly good physical properties.

Storable Fuels (See Table 2 for properties.)

Hydrocarbons—All large ballistic missile rocket engines now use hydrocarbon fuels. The principal one is RP-1, which resembles the kerosene jet fuels used in air-breathing engines. But it has a much narrower cut and contains little or no aromatics and olefins, so stability and storage properties are improved.

Hydrocarbon fuel densities are low; but the overall propellant bulk density is generally good, due to the high mixture ratios used for maximum specific impulse.

These high ratios make relatively little fuel available for regenerative cooling, necessitating oxidizer engines. Other disadvantages of hydrocarbon fuels include modest specific impulse, severe combustion stability problems when used with nitric acid, and unreliable hypergolicity (spontaneous combustion on fuel-oxidizer contact). They are also unsuitable for use with fluorine-based oxidizers.

Amines and Hydrazines—Although aliphatic amines don't perform better than hydrocarbons do, their advantages include high density, reasonable cost, maximum specific impulse delivered at fairly low mixture ratios, and spontaneous ignition and remarkably stable combustion with the principal storable oxidizers.

The most favored of the storable amine fuels is unsymmetrical dimethylhydrazine (UDMH). It's comparable costly, but the physical properties are excellent, performance is fairly high, and stringent freezing point requirements are easily met.

Mixtures of UDMH with diethylene-triamine have a density impulse 3% greater than with UDMH alone . . . but give a 1% lower specific impulse.

Hydrazine gives the highest density and specific impulse available from conventional fuel today—no matter which oxidizer is used. Although its physical properties are generally good, its high freezing point has precluded its use for many storable applications. And no freezing point depressants for hydrazine have been found. However, the development of hydrazine as a storable propellant is promising for larger ballistic missiles, since the environmental launch condition can be controlled to accommodate the high freezing point.

Hydrazine has another advantage—optimum performance at minimum mixture ratios, resulting in large amounts of fuel for regenerative cool-

Continued on page 117

Corten-Dolan Theory Predicts Chain Life

Based on paper by the theory to practice is:

WILLIAM F. HOFMEISTER

Chain Belt Co.

(Presented before SAE Milwaukee Section)

THE Corten-Dolan cumulative fatigue damage theory was used to predict total cycles to failure for random dynamic loading on chains operating over sprockets by the Chain Belt Co. In all cases tested, it correlated with experimental evidence.

This theory (explained in Fig. 1) takes into account all peak stresses to which the part is subjected. And it assumes that the various stress ranges are not applied in any given sequence.

The information required to apply

(1) Endurance limit diagram for the part or machinery in question.

(2) Load-time spectrum for service conditions.

(3) Cumulative fatigue damage relationship.

While it may appear that obtaining the information required for items (1) and (2) is impractical, to do so will undoubtedly be required to predict limited life accurately—no matter what further developments in the theory may be forthcoming. They are the basic elements of any strength of materials problem—static or dynamic.

To Order Paper No. S163 . . . on which this article is based, see p. 6.

Corten-Dolan equation:

$$N_g = \frac{N_1}{\alpha_1 + \alpha_2 \left(\frac{\sigma_2}{\sigma_1}\right)^a + \alpha_3 \left(\frac{\sigma_3}{\sigma_1}\right)^a + \dots + \alpha_i \left(\frac{\sigma_i}{\sigma_1}\right)^a}$$

where:

(Answer desired) N_g = Total cycles to failure

(From S-N diagram) N_1 = Cycles to failure for continuous stressing at σ_1

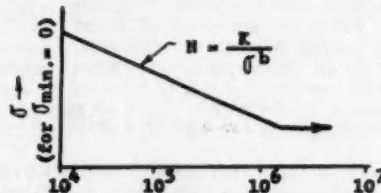
Data from knowledge of stressing (or loading) encountered in service

- σ_1 = Maximum applied stress
- σ_2 = Second largest applied stress
- σ_3 = Third largest applied stress
- σ_i = Minimum applied stress
- α_1 = Ratio of cycles N_1 at σ_1 to total cycles N_g
- α_2 = Ratio of cycles N_2 at σ_2 to total cycles N_g
- α_i = Ratio of cycles N_i at σ_i to total cycles N_g

$a = C \times b$ Note: The experimental work done at the University of Illinois showed that a value of C between 0.81 and 0.94 resulted in close predictions of total cycles to failure for steel specimens subjected to varying load ranges.

(From S-N diagram)

$$b = \frac{K' - \log N}{\log \sigma}$$



Note: The diagram above shows that to determine b , only the limited life portion of the endurance limit diagram need be established. The latter requires relatively little testing time compared to establishing the endurance limit. Testing must be conducted to at least 10 million cycles to have reasonable confidence that an endurance limit has been obtained.

Fig. 1

Fabrication Problems Pop Up Faster Than Solutions

Based on report by secretary

J. S. SOHN

Curtiss-Wright Corp.

THE complexity of structures with increased materials properties required for space age vehicles and missiles now in design and development are creating fabrication problems faster than they are presently being solved.

Two general groups of fabrication problems have been created by the new missile and space vehicle designs. The first deals with the use of materials of extreme hardness, abrasiveness, or brittleness in large structures under high stress. The second group of problems concern the use of very light weight, thin sheet metal structures of large size and complexity under relatively low stress.

An example of the first group is the motor case of a solid fueled rocket where stresses of 200,000 psi may exist, requiring the fabrication of steel at a Rockwell C hardness of 52 to 56. The structure of an hypersonic plane is typical of the second group where extensive use is made of ultra-thin honeycomb composites at low unit loads.

Continued expenditure in the refinement of existing techniques is yielding less and less improvement in fabricating increasingly difficult to work materials. The point of diminishing returns has been passed. Rockwell C 52 to 54 steels can be machined but only at great loss of speed and tool life. Large honeycomb panels with 0.002 in. cores can be brazed and formed but only at very high cost. Technological fabrication break-throughs are needed in the application of such techniques as spark machining, ultrasonic welding, and higher energy rate metal deformation.

Only the ingenuity of the designer and the fact that advanced missiles and space vehicles are needed by scores rather than by the thousands of World War II, permit present techniques to be used at all. Advances in fabrication techniques are needed comparable to the advance in destructive power of a hydrogen bomb over chemical explosives.

Serving on the panel which developed the information in this article, in addition to the panel secretary were: **Herman Hanink**, Curtiss-Wright Corp.; **William Bruckart**, Universal Cyclops Steel Corp.; **Howard Burns**, Thiokol Chemical Corp.; **Wilfred Dukes**, Bell Aircraft Corp.; **A. Kastelowitz**, Republic Aviation Corp.; **L. E. Laux**, The Martin Co.; and **John Maranchik, Jr.**, Metcut Research Associates, Inc.

(This article is based on a secretary's

report of a production panel entitled "Fabricating Ultra High Strength and Refractory Materials." This report — along with 6 other secretaries' reports on various production subjects — is available in multilith form as SP-327. See order blank on p. 6.)

Design Control Cuts Tooling Costs

Based on report by secretary

R. C. MEIER, Chrysler Corp.

CERTAIN design characteristics must be carefully controlled wherever possible if low cost tooling is to be achieved. These include:

1. Eliminate back-draft.
2. Eliminate or reduce areas where flange angles are more or less than 90 deg.
3. Provide contours so the part can be held in flanging position without special devices to prevent creep.
4. Provide fastening holes in such positions and relationships as to permit piercing without cam dies.
5. Design parts so trim and pierce areas are less than 15 deg off 90 deg trim angle positions.
6. Avoid contours which will require draw, redraw, reform, or restrike operations.
7. Keep in mind types of material with which you are working — gage and general physical properties commercially available.
8. Avoid difficult gaging problems on surface and hole relationships or locations.
9. Avoid designs which call for critical dimensions.
10. Avoid designs which call for multiple-pierce construction — combine parts and eliminate multiple sets of tools.
11. Incorporate simplified joining methods into design of parts becoming assemblies.
12. Avoid designs which require thin cross-section in dies, special types of materials in dies, or added operations to produce parts.

Serving on the panel which developed the information in this article, in addition to the panel secretary, were: **J. F. Kerigan**, Chrysler Corp.; **E. O. Warner**, General Motors Corp.; **W. S. Jakubowski**, Superior Tool & Die Co.; **P. H. Clapp, Jr.**, American Brake Shoe Co.; **J. S. Larkins, Jr.**, Elox Corp. of Mich.; **C. C. Mezey**, Chrysler Corp.

(This article is based on a secretary's

report of a production panel entitled "1959 National Production Forum." This report — along with 8 other secretaries' reports on various production subjects — is available in multilith form as SP-326. Order blank on p. 6.)

12 Engines Speed Fuel and Lube Tests

Based on paper by

L. S. ECHOLS
and F. J. CORDERA

Shell Oil Co.

A multiple-engine test facility has been developed which fills the gap between accelerated engine tests and road convoy tests. This 12-engine facility provides a research tool for obtaining reliable comparisons of the performance of fuels and lubricants under closely controlled and realistic conditions.

A variety of fuels and lubricants can be tested concurrently and under essentially identical conditions. Thus, for example, four fuels can be evaluated with each of three oils or vice versa. By running the engines under simulated road conditions with adequate starts, stops, and shutdown periods, the equivalent of 20,000 miles (the average metropolitan driver's two-year mileage) of road test in 12 engines can be accumulated in about four months.

Although instrumentation and controls are adaptable to a variety of operating cycles, the two in principal use have been a stop-and-go, winter urban driving cycle of 20,000 miles duration, and a high-temperature, high-speed, over-the-highway type of summer driving. These were selected after a careful study of driving habits. The winter cycle involves three periods of 6 hr each, the equivalent of 215 miles. Sixteen cycles each week provide the equivalent of 1146 miles and 19 weeks completes a 20,000-mile test.

Simulating Driving Conditions

Shutdown periods are adhered to rigidly since they are considered important in their effect on engine wear, rust, and deposits. During each week of operation on the metropolitan cycle there are 176 periods of 6 min each, four periods of 7½ hr and one 56-hr period. At each shutdown, engine coolant is circulated through the engine and heat exchanger to drop the engine temperatures quickly, thus simulating a longer shutdown period with a natural cooling rate.

In addition to complete performance evaluation of the individual fuels and lubricants, the test patterns make it possible to assess the effect of interactions between fuel and lubricant combinations, and to have considerable confidence in results as well as some judgment as to the variance of the test data.

To Order Paper No. 69T . . .
on which this article is based, see p. 6.

SAE NEWS



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EAB Set for Action . . .

. . . at Sept. 12 meeting in Chicago.

THE 1960 SAE Engineering Activity Board is holding its second meeting on Sept. 12 at the Edgewater Beach Hotel in Chicago. There it will take further steps toward readying itself for full action when it comes into official being next January.

Rules to Be Recommended

Important at this Sept. 12 meeting will be review and discussion of detailed recommendations for Board operating rules and regulations due from a committee headed by A. O. Willey. Working with Willey to formulate working rules for the new Board have been E. J. Manganiello and S. J. Tompkins.

Willey, a member of the new EAB,

is currently chairman of the SAE Meetings Committee, whose functions the new Board will encompass under the reorganization. Manganiello, also named to membership on the new Board, is currently SAE vice-president for the Aircraft Powerplant Activity. Tompkins, also an EAB member, is a Past Vice-President for Truck and Bus Activity . . . and is chairman of a subcommittee of the current Meetings Committee whose recommendations for change of Summer Meeting site and character have been approved by SAE Council.

New Meetings Planning

Scheduled to be heard from at this meeting is EAB's National Meetings

Planning Committee, which Tompkins chairs. This committee was named to develop and recommend a schedule of National Meetings for the Society. . . . Their recommendations will cover subject area, participating groups, place, date for each meeting.



A. O. Willey

Chairman Tompkins is aiming at a well integrated schedule of National Meetings, ever better coordination of the groups involved, and more effective use of members' time, talents, and dollars.

Serving with Tompkins on this new Committee are J. T. Dymont, F. W. Pink, C. F. Nixon, F. A. Robbins, and Randall Roman from the membership of the EAB. Also R. C. Norrie, E. B. Ogden, P. H. Pretz, W. L. Thompson, C. J. Livingstone and W. F. Shurts.

Display Group Named

To recommend policies governing the ever-growing SAE displays held in conjunction with various Society Meetings, EAB has established a Display Committee, headed by R. H. Isbrandt, who also is 1959 Chairman of the SAE Technical Board. Working with Isbrandt will be R. D. Speas, J. I. Hamilton, J. D. Redding, E. E. Bryant, and G. R. Fitzgerald.

Sponsors Already Active

Attending the Sept. 12 meeting are expected to be all of the Board members who have been appointed as sponsors for the various Engineering Activity Committees of the Board. So far, 15 Board sponsors have been appointed . . . to act as liaison between the Board and the committee each sponsors. They will advise the Board with respect to Committee personnel and as regards expediting of Committee work.

These 15 sponsors have been at work ever since their appointment last June establishing the membership of their respective Activity Committees — which must be ready to start functioning next January. In this work, they are seeking the help and advice of the member of the new SAE Board of Directors (previously Council) who was nominated by the Activity Committee to serve in 1960.

Each Activity Committee will elect its own chairman, when it first meets in January, 1960. So the sponsor will act as chairman pro tem to conduct the meeting during the process of electing a chairman. (The sponsor will withdraw his own name from consideration as chairman.)

The 15 sponsors appointed last June

SAE NATIONAL MEETINGS

• September 14-17

National Farm, Construction, and Industrial Machinery Meeting (including production forum and engineering display), Milwaukee Auditorium, Milwaukee, Wis.

• October 5-10

National Aeronautic Meeting (including manufacturing forum and engineering display), The Ambassador, Los Angeles, Calif.

• October 26-28

National Transportation Meeting, La Salle Hotel, Chicago, Ill.

• October 27-29

National Diesel Engine Meeting, La Salle Hotel, Chicago, Ill.

• October 28-30

National Fuels and Lubricants Meeting, La Salle Hotel, Chicago, Ill.

—and the Activity Committee for which each is a sponsor—were:

J. T. Dymant	—Air Transport Activity
F. W. Fink	—Aircraft and Missiles Activity
E. J. Manganiello	—Aircraft Powerplant Activity
D. M. Adams	—Body Activity
R. E. Cross	—Computer Activity
F. A. Robbins	—Powerplant Activity (formerly Diesel Engine)
C. F. Nixon	—Engineering Materials Activity
W. W. Henning	—Farm, Construction, & Industrial Machinery Activity
J. E. Taylor	—Fuels & Lubricants Activity
C. R. Lewis	—Nuclear Energy Activity
Karl Pfeiffer	—Passenger Car Activity
K. W. Stalker	—Production Activity
W. Paul Eddy	—Science - Engineering Activity
C. A. Brouer	—Transportation & Maintenance Activity
S. J. Tompkins	—Truck & Bus Activity

Publications Advisory Committee Important

No special report is scheduled at the Sept. 12 meeting from the newly appointed Publications Advisory Committee of the EAB, which is being chairmaned by V. G. Raviolo, who is a member of the EAB.

This important arm of the new EAB is designed to:

1. Assist the Board in development and administration of Board policies and procedures relating to evaluation and release for publication of technical material emanating from the Board.
2. Maintain effective procedural relationships between the Board and agencies of the Publication Committee.

Raviolo's committee is expected to concern itself, among other things, with formulation of practical procedures for review of papers, reports, and other technical material developed by Committees of the Board; appointment of one of its own members to be responsible, with the assistance of the SAE Journal editor, for stimulating and screening articles from overseas engineers and from U.S. engineers who travel abroad; and establishment of other channels of communication between the Board and the Publication Committee.

Serving with Raviolo on this EAB Publications Advisory Committee are: J. D. Redding, T. B. Rendel, Robert Anderson, and F. P. Steiner.

COORDINATORS . . .

. . . new arm of new Sections Board.

GETTING READY FOR ACTION

When it becomes "official" in January, 1960, the new SAE Sections Board will hold its second meeting in Chicago on Sept. 12. There it will develop further the concept of "Coordinators" to work with Section officers on a regional basis. Also it will appoint several new Sections Board Committees, in addition to the three which were named at the Board's organization meeting last June.

Ways will be sought at the Chicago meeting by which the proposed "Coordinators" may operate most effectively. A Coordinator's chief responsibility, according to Section Chairman W. F. Ford, would be to work with officers of a few Sections in his area of the country. The Coordinator would assist his group of Sections in:

- Organizing the Section for effective service to local members.
- Conveying Section questions and requests to the Sections Board.
- Keeping Section governing boards posted on SAE policies as they pertain to Sections and Groups and student activities in their local areas.

One point about Coordinators was definitely settled at the Board's meeting in June: "Sections and Groups represented by individual Coordinators shall not become political entities or pressure groups."

Progress reports are likely at the Sections Board's Sept. 12 meeting from the three committees appointed last June . . . the Section Administrative Committee, the Student Activities Committee, and the Section Finance Committee. Each of these committees is already working on a definition of scope for its operations . . . and is reviewing the appropriateness of the name by which it has been designated.



E. P. Lamb

E. P. Lamb is chairman of the Section Administrative Committee; E. P. White, of the Student Activities Committee; and G. J. Liddell, of the Section Finance Committee. White, currently chairman of the Student Committee, and Liddell, of an existing Section Finance Committee, will be continuing current committee work along similar lines under the aegis of the new Sections Board.

Serving with Lamb on the new Section Administrative Committee are F. D. Applegate, J. W. Pennington, H. A.

Helstrom, Jr., and W. G. Nostrand.

To work under White's chairmanship on the Student Activities Committee R. W. Noble, A. W. Denny, R. W. Rand, and A. D. Gilchrist were named at the June meeting.

Liddell will have with him on the Section Finance Committee: P. S. Myers, J. T. Dymant, L. L. McArthur, and R. C. Norrie.

REGIONAL Section Officers CONFER . . . at Vancouver

ELEVEN SECTIONS AND GROUPS came together on Monday, August 10 in Vancouver, B. C. for the first SAE Regional Section Officer Conference. Sessions were held in the Kent Room of Vancouver's Hotel Georgia.

The Conference idea grew from the organization meeting last June of the 1960 SAE Sections Board, which sees in such gatherings an important medium for stimulating the exchange of ideas for effective Section operation.

Sections and Groups invited to participate in this trail-blazing meeting were: Alberta, British Columbia, Colorado, Hawaii, Northern California, Northwest, Oregon, Salt Lake, San Diego, Southern California, and Spokane-Intermountain.

Some 20 Section officers and governing board members participated in the afternoon-long discussion which started when Conference Leader Otto E. Kirchner opened the luncheon session. Kirchner, a past SAE Vice President and 1959-60 chairman of the Northwest Section, pegged the Conference objective as "the interchange of ideas and discussion of problems concerning Section and Group operations."

Also in Vancouver to participate in the Conference were officials from the Society's top echelons, led by President Leonard Raymond and Section Committee Chairman W. F. Ford (who is also to be chairman of the new SAE Sections Board for 1960). SAE Secretary & General Manager John A. C. Warner; Hollister Moore, manager of Membership and Sections Division at SAE Headquarters, and E. W. Rentz,



Conference Leader was Otto E. Kirchner

You'll be interested to know that . . .

THE SECTION GOVERNING BOARD ROUNDTABLE LUNCHEON at Summer Meeting came up with some top quality ideas to assist Section and Group officers. Speakers from a dozen Sections — East, West, and the Middle West — reported on local programming which has paid off in higher technical content of meetings papers — and increased attendance and member interest. The suggestions included:

- Variety in local programming — with emphasis on areas appealing direct to the members' fields.
- A "do-it-yourself" meeting — drawing on men in the area for the entire program in lieu of an outside guest speaker — a sort of "local talent" night.
- Interest the young engineering graduate in Section activities by encouraging him to work with the students — getting good papers from students — and planning the Section's student meetings in general.

BONA FIDE COLLEGE AND UNIVERSITY FACULTY MEMBERS will not have to pay registration fee when attending SAE National Meetings, to encourage their participation in SAE activities.



C. R. Lewis

A PROJECT IS AFOOT to bring more students and faculty people into direct work on SAE technical activities. Dr. C. R. Lewis, Nuclear Energy Advisory Committee's chairman initiated the experiment — which may be extended to other SAE committees and activities.

SAE ENROLLED STUDENTS who apply for regular membership before March 31 following graduation will have initiation fee waived . . . and, further, their first year's dues will be prorated. If elected between Oct. 1 and Dec. 31 they will pay \$10; between Jan. 1 and March 31, \$7.50; after April 1, \$5.

BALTIMORE SECTION noticed pronounced increase in local activity in 1958-1959 after having been host to the National Transportation and Diesel Engine Meeting.

KEEP PAPERS TECHNICAL AND SPECIFIC was the unanimous answer of Central Illinois Section's Governing Board members when asked for paper-improvement ideas for the next Earthmoving Industry Conference Sessions.

KANSAS CITY SECTION makes immediate use of SAE Journal each month. A "word of welcome" goes out promptly to each new area member in the "New Members Qualified" column, and to all job-transferees listed in "News of Members." They are told they will be receiving Section meeting notices regularly . . . and that pin-presentation to the new member will take place at the first meeting he attends.

ONE SECTION is polling its membership about a new meeting place removed from the down-town area. Hoped for advantages: Substantial reduction in parking costs, and reduced over-all cost of meetings to Section members. The plan is to "try out" one such meeting early in the Fall.

NORTHERN CALIFORNIA SECTION finds reciprocal advantage in extending a helping hand to all engineering teachers in its area. . . . These teachers work with the Section in developing programs of special interest to the students.

Jr., manager of SAE's Western Branch Office attended also.

Specific ideas revealed during the discussion — which are scheduled for detailing in the October SAE Journal — touched many points far beyond the range of the pre-Conference agenda. Several Sections described projects in which their Sections had attained unusual success; many got light on problems of attendance, meetings operation, and financial controls which had been plaguing them with varied degrees of intensity.

The Conference was held on the first day of the 1959 SAE West Coast Meeting.

SECTION—Source . . .

. . . features are averaging 2 a mo. in Journal.

FORTY PERCENT OF SAE'S SECTIONS developed all the papers from which came 32 feature articles in SAE Journal in the last 2½ years. With Section-source feature articles averaging more than two per month since the beginning of 1958, the steadily growing value of technical ideas and information being produced by arrangers of Section meeting programs is clear.

Technical material is extracted from every Section (as well as National Meeting) paper as the basis for an article of some kind in SAE Journal. But, since the beginning of 1957 through July, 1959, Metropolitan Section papers score highest as the source of feature articles. Seven Met Section papers in this period have supplied the technical material needed for features.

Of these seven, four dealt with aeronautic subjects; two with ground vehicle topics; one with marine engines.

Next comes Detroit, with three papers supplying data for SAE Journal feature articles — all on ground vehicle topics. Papers presented at three Northwest Section meetings were the basis of Journal features, two of which were given also at other Sections.

Chicago, Philadelphia, San Diego, Southern New England, and Salt Lake each programmed two papers which later resulted in features.

Making up the rest of the 18 Sections whose papers so far have resulted in feature articles — one from each — are Baltimore, Central Illinois, Cleveland, Colorado, St. Louis, Texas, and Wichita.

At a recent meeting of the SAE Publication Committee, Chairman T. L. Swansen expressed his pleasure at the increasing participation of SAE Sections in development of the Society's technical literature. "Every year recently," he told the Committee, "the pages of both SAE Transactions and SAE Journal have been increasingly enriched by Section-developed technical material."

LETTERS . . .

. . . from readers.

From:

Fred M. Potgieter (M '30)
Agricultural Chain Division
Chain Belt Co.

Dear Editor:

I read the editorial on page 23 of the June issue with a great deal of interest, and I am quoting a copy of a letter that came to my attention as follows:

"We have always placed an extremely high value on organization and people. With well qualified people within an organization who have product background, experience, and knowledge and good customer contacts and relationships, other factors take care of themselves. Machinery can be purchased and plants built, but the key to the success of the business is the people that make it up."

This letter was written in connection with the acquisition of a small company by a large organization. I know this organization well and the success of the organization is in a large part due to their handling of people as so clearly stated in the above quotation.

From:

J. M. Campbell (M '37)
Scientific Director
Research Laboratories
General Motors Corp.

Dear Editor:

I just want to commend you for your column on Creativity that appeared in the July issue.

Only last week at a conference we had with a group of university educators, the thought was expressed that recent graduates are too often assigned to work that is beneath their capabilities. The example given was the case of a young man assigned to a job of taking down a lot of instrument readings, just as indicated in your column. My reply was essentially the same as the thought expressed in your column although not as succinctly expressed. I am mailing your column to the professor and I hope it will make a lasting impression.

I have lived through just such an experience myself, as all of us have at one time or another. In my case, I was once engaged in making seemingly endless measurements, month after month, of the knocking characteristics of pure hydrocarbons in an engine. To outsiders it looked like a very routine job. so much so that one of the engineers in another department in the laboratory exclaimed to Dr. Withrow one day, "How can John Campbell stand to do such a routine thing day after day?"

Of course it was tedious and pains-

taking and no one knew it any better than I. But I also realized the significance of the information I was getting and the fact that no one else in the world had the opportunity that I had to get it. Today every tankful of gasoline we buy — about 60 billion gallons annually — feels the imprint of that "routine," but very basic research, that I was doing 30 years ago along with Tab Boyd and Wheeler Lovell.

From:

C. M. Billings (M '12)
Upper Darby, Pa.

Dear Editor:

In reading Laurence Crook's article on the new U. S. small car (July issue), I note the same old misconceptions about the riding qualities of small cars vs. heavier cars.

Cars of light weight (not necessarily small) can be made today to ride as smooth as "big road locomotives" — for the reason that total weight bears no relation to riding qualities. Careful engineering in the design and the use of lightweight structural materials for the unsprung weight of the car's underpinning is the answer.

I have been rather busy this last year writing a history of the Rittenhouse Astronomical Society, the oldest in America devoted to amateur astronomy.

Last year I completed the design for a Monochrometer optical device (see



accompanying photograph). This is an optical device used with a telescope for viewing the great fires on the sun. It is one of only 12 in the United States . . . and is the only one available to the public. It is mounted on the 10-in. refractor Zeiss telescope of the Franklin Institute Observatory in Philadelphia.

Since its installation, it has given pleasure to thousands of school children and adults. As many SAE members know, these hydrogen flares on the sun are sometimes 8,000 to 30,000

miles thick, attain a length up to 200,000 miles, and stream out from the solar surface from 50,000 to 250,000 miles. (Haverford College photographed one in 1946 that reached out over 1,000,000 miles.)

From:

W. E. Lessing (M '50)
Central Freight Lines, Inc.

Dear Editor:

The paper by John Alden of Vauxhall Motors which was reported in the April SAE Journal contains an unusual amount of fresh information that is of immediate concern to us.

I was particularly interested in Mr. Alden's comment that while 16-in tires have shown a cost per ton-mile saving of up to 30% in comparison with 20-in. tires, the reason for the saving is not clear.

The following is a copy of an analysis of tire cost per ton-mile which I made almost nine years ago. It is based on the assumption supported by simple observation — that all tires have an approximately equal tread life when used at rated capacity. In this case, all tires were assumed to deliver 50,000 miles:

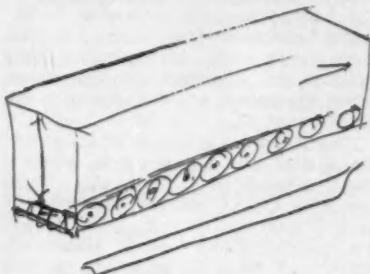
Size	Max Capacity, lb	Tire Cost, \$	Unit Cost, \$/ton-mile
7.00 x 20	2,000	31.36	1.565
8 ply			
7.00 x 20	2,250	40.84	1.82
10 ply			
6.00 x 16	1,140	14.96	1.31
6.50 x 16	1,290	18.45	1.43
6.50 x 20	1,950	29.60	1.52
7.50 x 20	2,200	40.68	1.85
8 ply			
7.50 x 20	2,700	48.48	1.80
10 ply			
8.25 x 20	2,900	53.84	1.85
10 ply			
9.00 x 20	3,450	66.68	1.94
10 ply			
10.00 x 20	4,000	84.56	2.22
12 ply			
10.00 x 22	4,275	89.08	2.08
12 ply			
11.00 x 20	4,500	99.56	2.22
12 ply			
11.00 x 22	4,750	105.24	2.22
12 ply			
7.00 x 15	1,380	24.26	1.76
7.00 x 16	1,440	21.45	1.49

It was, of course, interesting to note that the cost per ton-mile differential between the 6.50 x 16 and the 9.00 x 20 tires as shown above is precisely the 30% mentioned by Mr. Alden. This places us in the not unusual position of having some unused, and therefore worthless, information; while our British cousins proceed quietly to take advantage of the practical application without undue concern as to the reason why.

The most cohesive information I have been able to get concerning the

nature of this cost curve is that 16-in. tires are generally machine made, while a considerable amount of hand work goes into the 20-in. tire. This appears to affect the cost of the 20-in. tire adversely.

During the nine years that I have kept this information in my desk drawer, no one that I have shown it to has evidenced any interest in it on the grounds of reduced tire cost, possibly because the doodle I drew of a 72,000-lb gvwt trailer on 16-in tires looks as if it were drawn for laughs (see sketch below). Neither are we particularly concerned about the



amount of climbing that the driver has to do in highway service, although in city service this would be of some advantage (the advantage in many cases being offset by the increased vulnerability of the driver to injury when in a low seating position).

We are, however, increasingly faced with another factor which will in the future require a decrease in tire diameter; this is the continuing tendency of freight in common carriage to decrease in density, with an attendant need for more payload volume.

We now have under active consideration a tractor-semi-trailer unit to be used in line service which will be equipped with 16-in. or smaller wheels. I am in need of any and all information concerning 16-in. truck tires and brakes in highway service.

If you plan to attend—the

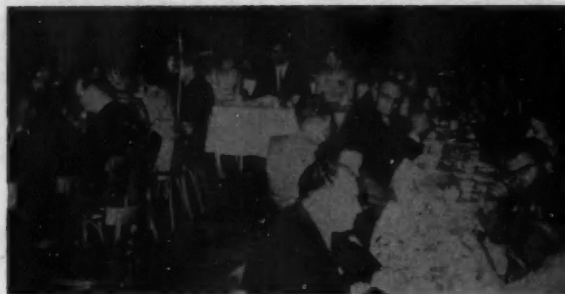
SAE Aeronautic Meeting

in Los Angeles, Oct. 5-9 . . .

. . . Your office or associates can reach you at a Special Message Center. The number is DUNKirk 1-2191.

This Center is being furnished through the courtesy of the Pacific Telephone Company.

SAE SECTIONS



SPOKANE-INTERMOUNTAIN SECTION held its Annual Dinner Dance June 6 at the BOF club. Approximately 50 members and guests were present.

SAE Section Meetings . . .

• Central Illinois

September 28 . . . Dr. Vern C. Vanderbilt, chief research engineer, Perfect Circle Co. "Development & Testing of Piston Rings." LaSalle Room, Hotel Pere Marquette, Peoria. Dinner 6:30 p.m. Meeting 7:30 p.m. Special Feature: Coffee Speaker.

• Chicago

October 13 . . . Chester E. McCollough, assistant, X-15 Research System Project, Air Research & Development Command. "The X-15 Research Aircraft." Knickerbocker Hotel, 163 East Walton, Chicago. Dinner 6:15 p.m. Meeting 8:00 p.m.

• Detroit

October 12 . . . Aeronautic & Missile Activity. Dr. A. Silverstein, project director, National Space & Aeronautics Administration. "Manned Space Flight." Dinner and Technical Session.

• Indiana

October 15 . . . Transportation and Maintenance Meeting. Speaker will be Carroll Boyce, editor-in-chief, Fleet Owner Magazine. Continental Hotel, Indianapolis. Social hour 6:30 p.m. Dinner 7:00 p.m. Meeting 8:00 p.m.

• Metropolitan

October 15 . . . Fuels and Lubricants Dinner-Meeting. Holger Ridder, Detroit editor, "Fleet Owner." "The Impact of the Compacts." Brass Rail Restaurant, Fifth Ave. and 43rd St., New York, N. Y. Cocktails 5:30 p.m. Dinner 6:30 p.m. Meeting 7:45 p.m.

• Mid-Continent

October 16 . . . Passenger Car Meeting. Bartlesville, Oklahoma.

• Northern California

October 28 . . . Diesel Meeting. Engineers Club, San Francisco. Dinner 6:30 p.m. Meeting 8:00 p.m.

• San Diego

October 13 . . . Paul Mantz, Paul Mantz Flying Service. "World War I Aircraft." I.A.S. Building, Harbor Drive, San Diego. Dinner 7:00 p.m. Meeting 8:15 p.m.

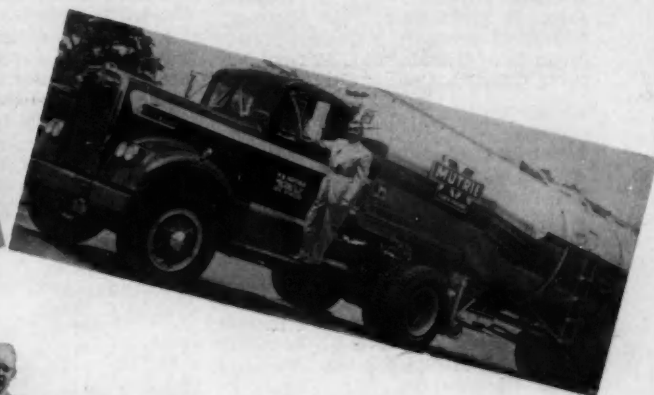
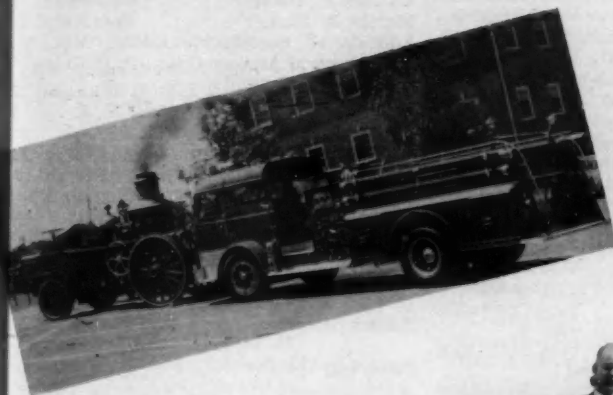
OCEAN HOPPING LIGHT-PLANE PILOT, Max Conrad, who made the longest distance single engine flight, will be guest speaker at Williamsport Group's meeting September 14. Conrad made his record breaking flight of 7683 miles from Casablanca, Morocco in North Africa to Los Angeles in his Lycoming powered Piper Comanche. The new distance record broke the existing one by 827 miles.

The group held its first Governing Board meeting June 22. It was decided to make every effort to contact and formally invite SAE members from Clearfield County, Pa., which has been added to the group's territory. The board pictured at right includes (left to right) H. J. Lavo, chairman; J. C. Hughes, membership committee chairman; D. S. King, meetings co-chairman; W. R. Horak, meetings chairman; W. C. Jamouneau, reception chairman; J. H. Carpen-



ter, past chairman. Standing (left to right) B. L. Sharon, treasurer; G. S. Creighton, public relations chairman; Joseph Haag, placement chairman; G. R. Schramm, secretary.

Old and new got together at New England Section's meeting



"OLD-TIMER" VEHICLE, operated by past-chairman O. E. Johnson, is part of a display provided by prominent manufacturers at New England Section's 31st annual summer outing. It was held June 1 at Woodland Golf Club in Newton, Mass.

The more modern tank truck rig on Kenworth chassis is shown with Gustav Heiber. The City of Boston Fire Depart-



ment contributed the old and new in fire apparatus. The outing of 300 members also included a golf tournament and concluded with a dinner and prize drawing.

Seated at the Woodland Club are (left to right) O. E. Johnson, 1958-59 Section Chairman, J. E. Jorgensen, Outing Chairman, and R. G. Douglass, 1959-60 Section Chairman.



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Continued

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... continued

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SAE TECHNICAL COMMITTEES



Japanese Spring Experts Visit SAE Headquarters

Leaders of the Japanese spring industry heard M. Leroy Stoner, secretary of the Technical Board (in center panel), describe SAE's relationship to American industry at Society Headquarters on August 11.

The 12 visitors formed a Spring Manufacturing Study Team sponsored by the U. S. International Cooperation Administration. For several weeks, they have toured spring-manufacturing plants in the Mid-West and New England.

Simultaneous Translation

Simultaneous translation equipment was used during Mr. Stoner's talk. It

is shown in the first panel at left. Seated from left are: Tamezo Komatsu, president, Marujo Spring Mfg. Works Co., Ltd.; SAE Member Harumoto Sugisaka, chief, Technical Division, Japan Spring Manufacturers Association; Atsushi Watari, professor, Dept. of Mechanical Engineering, Institute of Industrial Science, University of Tokyo; and Official Team Interpreters Masumi Muramatsu and Tomokatsu Kobayashi.

In center panel are: M. L. Stoner, SAE staff; Shigeo Uchigaki, chief of Technical Department, Mitto Sangyo Co., Ltd.; and Rex Ramsay, project escort, International Cooperation Administration.

In panel at right are: Kenji Nakatsuka, president, Tokushu Spring Industry Co., Ltd.; Toichi Hibi, managing director, Sanko Senkai Co., Ltd.; Hisao Morita, president, Horikiri Spring Co., Ltd.; Yoshiichi Aiba, president, Togo Mfg. Co., Ltd.; Saburo Kato, president, Kato Spring Co., Ltd.; Katsushi Suzuki, director and chief of Manufacturing Dept., Chuo Spring Co., Ltd.

Others Present

Others who were present but who are not shown include: Takatoshi Hayashi, president, Chuyo Spring Co., Ltd. and Shoniro Nakano, chief of Business Department, Nakano Spring Manufacturing Co. Ltd.

Radioisotope Group Meets in Warsaw

THE United States participated in the first plenary meeting of Subcommittee 4 on Radioisotopes of the International Standards Organization (ISO) Technical Committee 85 at Warsaw, Poland, on April 21-22.

U. S. Represented by ASA

The United States was represented by the ASA Nuclear Standards Board Subcommittee on Use and Handling of Radioisotopes and High Energy Radiation (N5.4). SAE is represented on this committee by Dr. Charles R. Russell, who is now its chairman.

At this meeting the scope of the committee's responsibility was broadened to include all aspects of production, measurement, handling, and all forms of use of radioisotopes, natural and artificial.

Priority Standards

Priorities for standards were determined to be: (1) sealed sources, (2) unsealed sources, and (3) packaging. The United Kingdom was elected secretariat for sealed sources; the United States for unsealed sources; and Poland for packaging.

J. Domanus, chairman of the Nuclear Energy Commission, Polish Standards Committee, was chairman of the meeting. Delegates from 12 nations attended.

Clutch Mounting Report Approved

FLYWHEELS for Single-Plate Spring-Loaded Clutches, a new SAE Recommended Practice, has received Technical Board approval for inclusion in the 1960 SAE Handbook.

The joint CIMTC—Engine Committee report was developed to reduce the great number of present-day clutch mountings. It includes nominal clutch sizes 6-10 which are not covered in an existing report.

W. E. Klatt, Waukeshau Motor Co., serves as chairman of both the CIMTC and Engine Committee subcommittees which prepared the report.

Sixteen Technical Committees Assigned to the Automotive

This is the second . . .

. . . in a series of four stories on the newly formed Councils of the SAE Technical Board. The Board's reorganization is described in full on pages 106 and 107 of the July issue.

THE sixteen SAE technical committees now under the Automotive Council are chiefly concerned with cooperative engineering work which results in the development of technical reports, recommendations, and standards. Their ultimate product is related to:

- Automobiles, trucks, buses and other highway vehicles.

- Off-highway vehicles such as tractors and farm machinery.

- Construction and industry machinery.

- Powerplants, drives and controls for all the vehicles and machinery listed above.

- Marine engines and related subjects.

Empowered by the SAE Technical Board, the Automotive Council will govern and review all technical reports emanating from committees under it.

George J. Huebner, Jr., who heads Chrysler's Research Section, has been named chairman. Although new members are in the process of being invited to serve on the Council (their appointments will be covered in future issues of the JOURNAL), the following form its initial membership: Robert R. Burkhalter, executive engineer, Dana

Corp.; Oliver K. Kelley, chief engineer, Buick Motor Division; Andrew A. Kucher, vice president, engineering and research, Ford Motor Co.; C. A. Lindblom, vice president in charge of engineering, International Harvester Co.; and A. E. Williams, Great Lakes Trailer Co.

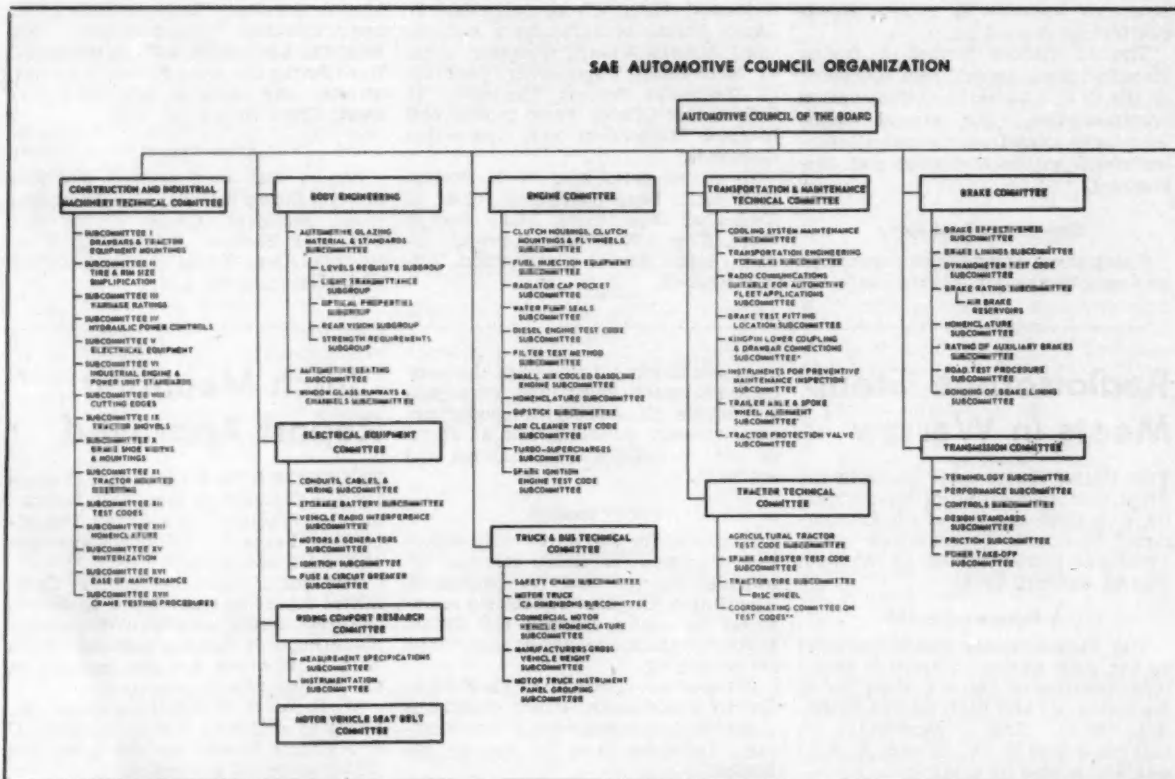
Among the reports developed during the past year by groups now under the Automotive Council are:

Lube Oil Filter Performance Test

The diligence of the Filter Test Methods Subcommittee of the Engine Committee paid off when its Lube Oil Filter Performance Test was released last year. It took approximately ten years to eliminate the possible sources of variation in test results.

The test procedure is concerned with four things:

SAE AUTOMOTIVE COUNCIL ORGANIZATION



Council

- Selection and processing of standardized contaminants.
- Contaminant storage, handling and addition.
- A simulated oil-flow lubrication (test) system.
- A method for analysis.

This report appears in the 1959 SAE Handbook and has also been issued separately as TR 160.

Mechanical Power Outlet Test Code

A more accurate measure of power available to drive winches, grinders, pumps and diggers may be achieved through use of SAE's new Mechanical Power Outlet Test Code.

Developed by the Construction and

Continued on next page

Initial Membership



Huebner



Burkhalter



Kelley



Kucher



Lindblom



Williams

GEORGE J. HUEBNER, Jr. is chairman of the Automotive Council as well as a Technical Board member, president of the Board of Directors of the Coordinating Research Council, and a member of both the Passenger Car Activity Committee and Publication Policy Committee. At Chrysler, Huebner is the executive engineer in charge of the Research Section.

ROBERT R. BURKHALTER joins the Automotive Council after having served as 1958 SAE Vice President for the Truck and Bus Activity. Currently a Technical Board member, he has served on the Overseas Information Committee, Buckendale Lecture Committee, Parts and Fittings Committee, Transportation and Maintenance Activity Committee, and the Detroit Section Board. At the Dana Corp., Burkhalter is executive engineer.

OLIVER K. KELLEY was chairman of the Technical Board in 1958. During that year he also received the fifth annual L. Ray Buckendale Award in recognition of his work in the automatic transmission field. An SAE member for 33 years, he has served as chairman of the Transmission Committee. At General Motors, Kelley is chief engineer of the Buick Motor Division.

ANDREW A. KUCHER is a member of the Technical Board's Executive Committee and of the Nuclear Energy Advisory Committee. He is also Technical Board Sponsor for the Engine Committee and the Transmission Committee. As vice president of engineering and research at Ford Motor Co., Kucher directs all product engineering, research, and testing activities.

As **C. A. LINDBLOM** joins the Automotive Council, he is a member of the Publications Committee. The 1954 meetings vice chairman of the Truck and Bus Activity, he is assistant to the vice president in charge of engineering at International Harvester Co. Prior to joining International Harvester, Lindblom was chief engineer for the White Motor Co.

A. E. WILLIAMS is a Technical Board member and sponsor of the Trailer Hitch Committee. He has served on the Truck and Bus Technical Committee and is now a TMTC member. Upon retiring as Fruehauf Trailer's executive vice president of manufacturing and engineering last year, Williams became affiliated with the Great Lakes Trailer Co.



* JOINT TRANSPORTATION & MAINTENANCE AND TRUCK & BUS

** JOINT CONSTRUCTION & INDUSTRIAL MACHINERY AND TRACTOR TECHNICAL

*** JOINT LIGHTING AND OPTICAL MATERIALS

Automotive Council . . .

. . . continued

Industrial Machinery Technical Committee, the code measures the power take-off output of tractors, graders, stationary powerplants, and other automotive vehicles.

In addition to determining fuel consumption for specific power applications, the code makes it possible to find out if power transmission components will withstand forces resulting from the dynamics of power transmission.

The report will appear in the 1960 SAE Handbook.

Truck Transmission Test Code

A means of comparing truck transmissions was developed by the Transmission Committee as a new SAE Recommended Practice. Outlined is a series of tests covering a transmission's range of operation. Also given is a method of presenting the data obtained from these tests.

Lubrication Intervals and Charts

Ease of maintenance is behind the development of two new recommended practices which cover:

(1) **Lubrication Intervals**—Construction and Industrial Machinery—This report provides a uniform color coding used in showing lubrication intervals on charts in manuals and at lubrication points on machines.

(2) **Lubrication Chart**—Construc-

tion and Industrial Machinery—Suggested is a format for charts to be permanently mounted on machines.

Both Construction and Industrial Machinery Technical Committee reports will appear in the 1960 SAE Handbook.

SAE Tractor Test Code

The Tractor Test Code has been extensively revised to cover crawler as well as wheel-type tractors. This was accomplished through close cooperation of the Tractor Test Code Subcommittee and Nebraska Test Board.

Another feature of the code is the establishment of a single fuel setting which enables one test procedure to be applied to tractors having diesel or carbureted engines. Previously, in some cases, an additional test was required for the latter.

A supplement to this test code is the new Tractor Tire Load and Inflation Standard which establishes loading and inflation pressure relationships for tire sizes and ply ratings used on agricultural tractors.

Both reports will appear in the 1960 SAE Handbook.

Air Brake Reservoir Test Code and Inspection Procedure

This new Brake Committee report provides a realistic test procedure for air brake reservoirs used in automotive applications. Requested by the Automobile Manufacturers Association, the code was developed by engineers ex-

perienced in air brake reservoir construction and testing.

Incandescent Lamp Impact Test

A practical laboratory impact test for use in military and rough service applications is contained in the new SAE Recommended Practice, Incandescent Lamp Impact Test. The test establishes minimum requirements for such bulbs when tested in accordance with the recommended procedure.

Light Output Meters

This new recommended practice provides a laboratory test procedure for light output meters to determine their ability to measure the light output of headlamps, fog lamps, and auxiliary driving and passing lamps, within prescribed tolerances. The report was developed by the SAE Lighting Committee.

Sealed Lighting Units for Construction and Industrial Machinery

Applicable only to replaceable sealed floodlamp and headlamp units on off-highway vehicles and machines generally known as earth-moving equipment, the new recommended practice is also a project of the Lighting Committee.

The foregoing is only a brief sketch of what committees under the Automotive Council do. It is meant to give SAE members some idea of the extent of Automotive Council work.

Technishorts . . .

CRANKCASE OIL VISCOSITY CLASSIFICATION—Information on multi-viscosity numbered oils was added to this SAE Recommended Practice by the Fuels and Lubricants Technical Committee last spring. The revised report clarifies and supersedes the existing SAE Information Report, Multi-Viscosity Number Oils.

TORQUE REQUIREMENTS FOR SPARK-PLUG INSTANTION—Torque requirements for 18-mm tapered seat plug sizes were added to this report during a review by the Electrical Equipment Committee. The new requirements will appear in the 1960 SAE Handbook.

J. H. VENEMA of Ford's Engineering Laboratories has been appointed chairman of the Editing and Correlating Subcommittee of SAE's Aeronautical-Automotive Drawing Standards Committee. He succeeds Wayne Stone of AVCO's Lycoming Division. The group is responsible for the final text and format of the Joint Aeronautical-Automotive Drafting Manual which will be released after the first of the year.

The Iron and Steel Technical Committee's Division 9—Automotive Iron Castings—has set up a special Specifications Subdivision. The group will be headed by **F. B. ROTE**, Albion Malleable Iron Co., who is also chairman of Division 9. Its purpose is to review the procedure for specifying iron casting grades. The Subdivision will attempt to develop a more realistic procedure which will expedite the addition of new grades and the revision of existing grades.

R. W. WAYMAN of Borg-Warner's Warner Gear Division is the new chairman of the Transmission Committee's Controls Subcommittee. The Subcommittee is currently formulating a series of diagrams outlining various stages of control transition. Wayman succeeds **W. R. Rodger**, Chrysler Corp.

A SPEW TEST has been added to SAE's Recommended Practice on Fiberboard Test Procedure. The new test will enable vehicle designers to evaluate the tendency of fiberboard materials to stain automotive trim. The revised report will appear in the 1961 SAE Handbook.

Helicopter Turbo Standard in Offing

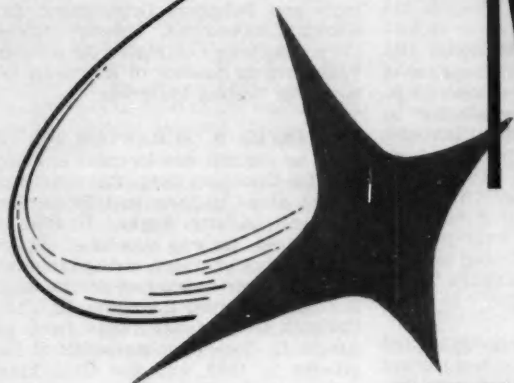
THE need to present helicopter turbo-shaft engine performance data as distinct from engine data suitable for turboprop or pure jet operation has caused the Joint E-21—S-2 Helicopter Powerplant Subcommittee to form a new Performance Presentation Panel.

With **Robert Lynn** of Bell Helicopter as chairman, the new group will develop a standard form for presenting data on helicopter turbine engines. It will begin by focusing its attention on parameters considered common in all normal helicopter turboshaft engine installations.

At its last meeting, the Joint Subcommittee suggested the form include:

- (1) Maximum and normal power at sea level and at each 5,000 feet to 30,000 feet.
- (2) Curves of horsepower versus altitude.
- (3) Curve showing fuel flow.
- (4) Curve showing horsepower versus temperature up to 95 degrees at altitudes up to 10,000 or 15,000 feet.
- (5) A method for calculating inlet and exhaust outlet losses.

SAE MEMBERS



LESLIE PEAT has become president of the newly-formed Lee-Peat Publishing Corp. which has acquired *Motor Truck News*, formerly the property of Empire State Highway Transportation Association. Peat will also continue as editor of *Motor Truck News*, a position he has held for the past seven years. He plans to maintain the magazine's established editorial policies, but to augment its news staff for more intensified reporting of news and feature events. Peat has long been active in SAE work and was chairman of its Metropolitan Section in 1952-53.

JOSEPH J. ROZNER has been elected president of Aetna Ball and Roller Bearing Co. He is also vice-president and member of the board of directors of Parkersburg-Aetna Corp. He formerly served as chief engineer, works manager, and vice-president in charge of operations.

GEORGE W. BROWN has been elected president and will serve as chief executive officer of Wagner Electric Corp. He was also elected president of its subsidiary, Wagner Brake Co., Ltd. Brown joined the company in 1926 as a student engineer. In 1952 he became executive engineer. He was elected vice-president in charge of manufacturing, engineering, purchasing, and industrial relations in 1954, director of the corporation in 1956 and executive vice-president in 1958.

BRET P. B. de DUBÉ, formerly managing director of TelAutograph International Division of TelAutograph Corp., has been elected vice-president of Comptometer Corp., Electrowriter Division, in charge of all overseas operations.

ELDRED E. EVANS has been named general manager of Kansas City Division of Bendix Aviation Corp. Previously he was assistant general manager of the division.

FLOYD KISHLINE has retired as chief engineer of American Motors Corp. Kishline joined the automobile industry in 1914 as an experimental engineer with King Motor Car Co. After serving in World War I as first lieutenant in the Army Transportation Corps, he worked with Graham Brothers, Inc., Dodge Brothers, Willys-Overland Export Corp., and Graham Paige. He joined Nash Motors Division, American Motors Corp., in 1939 as assistant engineer and was appointed to his recent position two years later. Kishline has worked to develop the six-cylinder engine and Rambler's all-welded single-unit construction. In 1934 Kishline served as SAE vice-president representing Passenger Car Engineering.

JOHN F. ADAMSON has been appointed chief engineer of American Motors Corp. Wisconsin automotive operations to, succeed **Floyd Kishline**. Adamson, formerly assistant chief engineer, joined American Motors in 1947 as a designer in Nash Motors Division.

WILLIAM F. LOWE recently received the Hanlon Award, conferred each year for outstanding service to the gas-processing industry. Lowe is executive director of the Natural Gasoline Association of America. He was SAE Mid-Continent Section Chairman in 1942-43.

CAPT. JOHN JAY IDE, USNR, was re-elected Vice President of the International Aeronautic Federation (FAI) at its May conference in Moscow. He was also elected Chairman of its Sporting Committee.

D. K. HEIPLE, formerly chief field engineer, has been appointed manager of the newly formed Sales Development Department at LeTourneau-Westinghouse Co. In his new position Heiple will continue to have charge of field engineering activities and in addition will be responsible for the company's marketing research and sales engineering programs. He is a member of SAE Construction & Industrial Machinery Technical Committee and author of "Earthmoving, an Art and a Science."

LELAND D. COBB has become president of the Continental Engineering Corp. Previously he was manager of research and development with New Departure Division, General Motors Corp.

GEORGE ROMNEY, president of American Motors Corp., has been named "Association Man of the Year" by the American Society of Association Executives.

continued



Brown



de Dubé



Kishline



Adamson



Peat



Rozner



Lowe



Heiple

SAE Members

continued

A. J. UNDERWOOD is retiring as manager of SAE Journal's Detroit advertising office, after serving in that capacity since 1933. Underwood graduated from Yale's Sheffield Scientific School, and engaged in engineering work before entering the advertising sales field. He has served as sales engineer at Hyatt Roller Bearing Co. He was also an executive in the standard's department of SAE headquarters staff, and played an important role in development of SAE's aeronautical program. Underwood plans to retain his home at Orchard Lake, Mich., and to continue his winter residence at Delray Beach, Fla.

LESTER M. KOELSCH, formerly vice-president and chief engineer with Koerper Engineering Associates, Inc., has become president of Star Design & Development Co.



Underwood



Fielder



MacFarlane



Clouser



Fredhold



Flynn



Eaton



Munger

FREDERICK A. FIELDER has been elected vice-president and general manager of Baldwin-Lima-Hamilton Corp.'s Loewy-Hydropress Division. His former position, which he had held since 1955, was general sales manager and assistant general manager of the division.

WARREN C. MacFARLANE, JR., vice-president and general manager of Detroit Division of Midland-Ross Corp., assumes additional responsibility as general manager of Cleveland Division. MacFarlane will devote his entire attention to the Cleveland Division at the close of the current automotive model year when the Detroit Division will terminate its operations. Prior to joining Midland in 1957, he served as vice-president in charge of manufacturing for Minneapolis-Moline Co.

WALTER CLOUSER recently retired from full time duty as vice-president in charge of sales with Muskegon Piston Ring Co., after 15 years of service. He will continue to serve as a sales consultant.

ALLAN B. FREDHOLD has been appointed general manager of Hadco Engineering Co., a subsidiary of Interstate Engineering Corp. of Anaheim, Calif. Formerly, Fredhold was general manager of General Logistics Division, Aeroquip Corp.

HAROLD O. FLYNN is assistant chief engineer in charge of trucks with Chevrolet Motor Division, General Motors Corp. Flynn has had charge of truck chassis design for the last two years. He now assumes charge of body design, which gives him the full truck engineering responsibility.

HAROLD H. SCHROEDER has been appointed to the newly created position of director of car body research and development with Chevrolet Motor Division, General Motors Corp. Previously he was staff engineer in charge of passenger car bodies.



Schroeder



Scranton



Earle



Lane

F. L. LaQUE, vice-president and manager of Development and Research Division, International Nickel Co., has been nominated for president of the American Society For Testing Materials.

C. F. NIXON, head of Electrochemistry and Polymers Department, Research Laboratories, General Motors Corp., has been nominated for a three-year term as director of American Society For Testing Materials.

CHARLES J. SCRANTON has retired as general development engineer at Allis-Chalmers Mfg. Co. Scranton joined Allis-Chalmers in 1934 as chief engineer, LaPorte Works. In 1957, at his request, he was appointed general development engineer, giving him more time to devote to product development. Scranton received the Cyrus Hall McCormick Gold Medal Award from the American Society of Agricultural Engineers in 1952, and the Gold Merit Award of the Farm Equipment Institute in 1957. He will reside in LaPorte and after a rest, plans to travel.

SHEROD L. EARLE has been promoted to supervisory mechanical engineer, head of Mechanical Engineering Department, U. S. Naval Engineering Experiment Station, Annapolis, Md. Although he has been acting in that capacity much of the time, his previous position was head of the Internal Combustion Engine Laboratory. In 1957 Earle was one of the three Internal Combustion Engine Laboratory engineers cited for a Special Service Award. He is a member of the 1959 SAE Diesel Engine Activity Committee and is vice chairman of SAE Baltimore Section.

JOHN E. LANE, previously a sales engineer at Dana Corp., is now sales manager of Clutch Division, Dana Corp. Immediately prior to joining Dana in 1955, he was for three years parts and accessories manager at Detroit for Studebaker-Packard Corp.



Mason



Jerstad



Ryndress



Lopez

THOMAS CARMICHAEL recently retired as an administrative engineer, field investigation department, General Motors Corp., after being with them for 30 years. Carmichael and his wife plan to build a home in Iowa.

GEORGE A. STONEX succeeds Carmichael as field investigation engineer, General Motors Corp. Prior to his new position he served as field investigator, after being head of the engineering test department, General Motors Proving Ground.

JAMES McDONALD has been named assistant general manager, western division, of Tidewater Oil Co. McDonald joined Tidewater in 1940 as a junior process engineer. Subsequently he became assistant process superintendent and assistant manager of Delaware refinery. Prior to his new position he was administrative manager of manufacturing.

JOHN D. WILLIAMS, president of Lipe-Rollway Corp. and Rollway Bearing Co., has been presented by the Syracuse Rotary Club with the Club's "Citizen of the Year" award for his activities as president of the Manufacturers Association of Syracuse.

DAVID C. EATON, previously director of marketing, is now director of corporate planning with Thiokol Chemical Corp.

JAMES H. MUNGER, formerly sales representative with Garlock Packing Co., has been appointed to the International Packings Corp. field sales force, Cooney & Conner, Inc.

E. GILBERT MASON, former director of industrial design for American Airlines, Inc., has been appointed director of research, development, design, and marketing at Hardman Tool & Engineering Co., a subsidiary of Dayton Rubber Co.

WALLACE H. JERSTAD has retired as production body engineer of American Motors Corp. Jerstad joined American Motors in 1923 as a draftsman at the Kenosha plant. In 1942 he was transferred to the Milwaukee body plant as chief inspector of aircraft engine parts and in 1947 he was given charge of all body engineering at the Milwaukee plant. Later he returned to Kenosha and was named production body engineer in 1954.

ROBERT P. RYNDRESS has joined Norma-Hoffmann Bearings Corp's field sales force and will represent the company in the Detroit area. Formerly Ryndress was associated with Marlin-Rockwell Corp. as sales engineer.

CESAREO LOPEZ has become plant manager and chief engineer with Fuller Do Brasil S. A., a subsidiary of Fuller Mfg. Co. Formerly he was research engineer with Borg-Warner Corp.

CLIFFORD A. PHILLIPS has been named administrative manager of manufacturing with Tidewater Oil Co. He joined Tidewater in 1950 as an associate engineer and served them successively as operating supervisor, project engineer, chief refinery engineer, and area supervisor of desulfurization and hydrogen units. Prior to his recent promotion he was superintendent of crude distillation, fluid coking and catalytic cracking operations at their Delaware refinery.

WILLIAM F. HUMPHREY, has been made director of sales for Hercules Motors Corp. He has served Hercules as manager of various branches as well as manager of West Coast retail sales, and manager of oilfield sales division. Prior to his recent promotion he was midwest district sales manager.

DAVID M. GASKILL has become sales manager with Green Mfg., Inc. Previously he was sales manager with Airborne Instruments Laboratory Division, Cutler-Hammer, Inc.

JOHN M. GERTY has become general manager with True Cast Concrete Products Co. Formerly he was experimental engineer with AC Spark Plug Division, General Motors Corp.

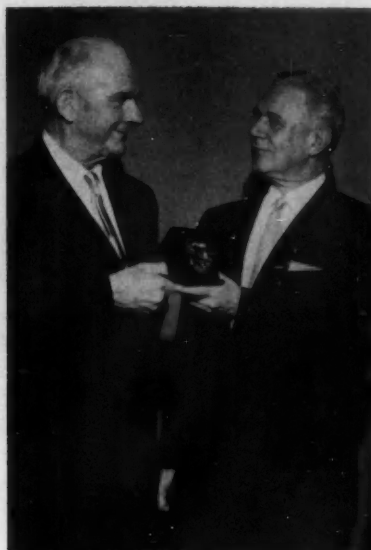
CLAUDE V. HAWK has been appointed to the newly created post of divisional director of reliability at Harrison Radiator Division, General Motors Corp. Previously he was assistant chief engineer in charge of heat exchangers and advanced design.

WILLIAM A. RAFTERY, sales manager at Signal-Stat Corp., has been appointed vice-chairman of the Joint Operating Committee for the 1960 International Automotive Service Industries Show.

DELBERT L. ROSKAM, formerly vice-president and general manager of commercial aircraft division, Cessna Aircraft Co. has been appointed to the newly created position of vice-president in charge of aircraft divisions.

DAVID I. DILWORTH, JR. has been made vice-president and assistant to president at Braeburn Alloy Steel Corp., a division of Continental Alloy Steels, Inc. Previously he was director of metallurgy at Crucible Steel Co. of America.

DR. RAY P. DINSMORE, vice-president of research and development for Goodyear Tire & Rubber Co., was recently honored for 45 years service with the firm, as he was presented with a 45 year service emblem by chairman of the board E. J. Thomas. Dinsmore's career has been highlighted by his receipt of Colwyn Gold Medal in 1947, awarded by the Institution of the Rubber Industry, and the Charles Goodyear Medal in 1955, awarded by the Rubber Division, American Chemical Society.



DR. AUGUSTUS B. KINZEL (right) received the Stevens Powder Metallurgy Medal from Dr. Willis H. Taylor, Jr., chairman of the Stevens Institute of Technology's Board of Trustees, in the Institute's new Science Engineering Building, May 6.

RAY T. BAYLESS is retiring as assistant secretary of American Society for Metals. Bayless joined the Society staff in 1922 after serving for two years as secretary of Cleveland Chapter of American Society for Steel Treating, forerunner of ASM. For 37 years he directed technical programming for National Metal Exposition and Congress ("Metal Show") and more recently had the same duties for ASM Western Metal Exposition and Congress. During his ASM career he has been editor of "Transactions," secretary of Transactions Committees, and editor of "Metals Review," ASM's monthly news magazine. Before joining ASM, Bayless served with Michigan Smelting and Refining Co., General Motors Corp., Chalmers Motors Co., and Saxon Motor Car Co. He was also supervisor of tests, U. S. Army Ordnance Department, and consulting metallurgical engineer with James H. Herron Co. Bayless and his wife will continue to live in the suburbs of Cleveland.

DR. PHILIP WEISS is to head the newly formed Polymers Department of General Motors Corp. Before joining General Motors in 1957, Weiss was research chemist with American Cyanamid Corp., and senior project chemist for Colgate-Palmolive Co. He joined General Motors as a research scientist and became assistant department head in 1958.

continued

SAE Members

continued

RICHARD E. RASMUSSEN has become president of Champion Engineering Products, Inc. His former position was general manager.

HOMI KAPADIA has joined Reynolds Metals Co. as international assistant to the director of corporate planning. Formerly Kapadia was technical consultant with Kawneer International, Ltd.

KURT O. TECH is vice-president of the newly formed company Cross-Malaker Laboratories, Inc., a subsidiary of the Cross Co. Tech was formerly vice-president, engineering, Cross Co.

WILLIAM E. FEW is now a consultant in chemical and metallurgical activities, offering personal services to industry and government. Formerly Few was technical assistant to general sales manager, Alloy & Metal Division, Tennessee Products and Chemical Corp.

ROBERT H. KOHR, vehicle dynamics supervisor for GM Research Laboratories Engineering Mechanics Department, recently disclosed the development of a ride simulator at General Motors Corp. The ride simulator, controlled by a giant analog computer, is a standard auto body minus wheels and engine which goes through lifelike motions subjecting its passengers to bounce pitch and roll. It aids in solving many complex suspension problems.

JOHN E. BACON is currently working as a civilian for the U. S. Army Ordnance Corps in the Rocket and Missile Component Section of the National Industrial Engineering Mission at Picatinny Arsenal, Dover, N. J. Bacon was previously design engineer with construction engineering department, International Harvester Co.



Rice



Owings



Buchi

JULIUS A. LUCAS, formerly manager, field sales, engineered products department with Goodyear Tire & Rubber Co., is now at the Akron office as assistant manager, engineered products department.

ROBERT H. HORNER succeeds Lucas as manager field sales, engineered products department at Goodyear Tire & Rubber Co. Formerly Horner was automotive products representative in charge of Chrysler account.

IRVING M. BANT has become manager of Grossinger Airport Division, Teterboro Aircraft Service, Inc. Previously he was concerned with maintenance of aircraft with the United States Air Force.

ANDREW F. HAIDUCK, formerly vice-president, has been named to the newly created post of group vice-president, Lear, Inc. The Electro-Mechanical and Romec Divisions will report to him in his new position.

CHESTER F. LENIK has been made district sales manager, Vickers, Inc., Division of Sperry Rand Corp. His previous position was application engineer, Vickers, Inc.

ROLAND PLOURDE, formerly special sales representative with International Electric Co., Ltd., has become general manager at McMullen Supplies, Ltd.

VERNE T. KOPPIN has been elected secretary of the American Society of Body Engineers, Inc. Koppin is chief draftsman with Creative Industries of Detroit.

JAMES H. W. CONKLIN has been named general sales manager of Pratt & Whitney Co., Inc. Previously he was general sales manager of Yale and Towne Mfg. Co.'s Material Handling Division. For the past three years he has been a management consultant in sales and marketing.

D. W. RICE has been appointed manager of the newly formed central sales section of Brown Trailer Division, Clark Equipment Co. Rice was formerly sales department administrative assistant.

KENNETH B. OWINGS has been appointed project engineer in charge of research and development of diesel and industrial lubricating oil filtration with Briggs Filtration Co. Formerly he was associated with the Tidewater Oil Co. as wholesale sales supervisor, Railroad Sales Eastern Division.

DR. ALFRED J. BUCHI of Winterthur celebrated his 80th birthday on July 11th. For six decades, Buchi has worked to embody in concrete applications—in a wide field of engineering—the idea of heat economy in diesel and gas engines. Buchi still continues to develop new ideas.

CHARLES R. AVERILL has recently become staff assistant at Aerojet-General Corp. His previous position was section supervisor, components test with Ford Motor Co.'s Aircraft Engine Division.

JOHN GLEB has become project supervisor in charge of space communication project (classified) with Electro-Optical Systems, Inc. Formerly he was vice-president and general manager of Intrex, Inc.

JOHN H. POLLOCK, formerly layout designer, is now design engineer with John Deere Dubuque Tractor Works.

SEBALD K. STAHL, previously design draftsman, is now design engineer with Caterpillar Tractor Co.

D. A. PUETT, formerly an engine rebuild specialist for Vinnell Corp., is now an equipment operations maintenance specialist with International Cooperation Association. In this position he will act as advisor to the Vietnamese on logistics, warehousing, and vehicular management for their country's Malaria Eradication Program.

FRED T. MILLER has become technical assistant to the president at Western Hydraulics, Ltd., a subsidiary of Borg-Warner Corp. Miller will continue to hold his previous position of regional sales manager.

PROF. WILLIAM H. GRAVES, head of the University of Michigan's engineering laboratory, prompted the recent gift of a \$100,000 mobile laboratory, which was presented to the College of Engineering by the International Nickel Co. The idea of a mobile laboratory was conceived by Graves who said it would aid in the study and solving of highway and automobile problems.

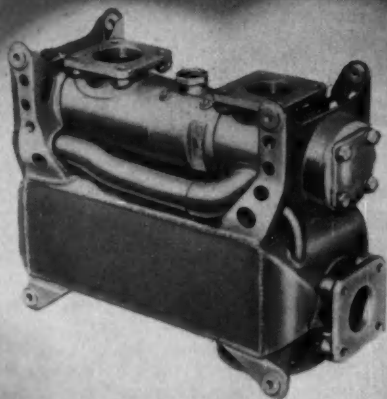
GEORGE B. D. PETERSON, formerly Detroit district sales manager for Aluminum Co. of America, has been named manager of direct selling and distribution.

JOHN W. COLLINS, formerly assistant district sales manager, succeeds Peterson as Detroit district sales manager, Aluminum Co. of America.

GAYLORD E. SMITH heads the Original Equipment Division of Muskegon Piston Ring Co. as sales manager. Formerly Smith was assistant sales manager, Original Equipment Division.

HORACE B. VAN DORN has been appointed to the newly created post of director of engineering at Fafnir Bearing Co. Formerly he was technical development manager.

continued



Reliable AiResearch fuel heater for the B-52



SPECIFICATIONS

Fuel Side (MIL-F-5624A, JP-4)

Fuel temp. in . . . -45°F

Fuel temp. out . . . $+33^{\circ}\text{F}$

Fuel flow . . . 10,500 lbs/hr

Air Side

Air temp. in . . . 480°F

Air flow . . . 90 lbs/min

Control — Integral automatic modulating thermostatic power element type.

• AiResearch is now in quantity production of an extremely reliable engine bleed air fuel heater which prevents icing in the B-52 engine fuel system during flight. This unit utilizes a minimum of hot compressor bleed air automatically modulated to keep fuel temperature above 32°F . Heating the fuel in flight overcomes the icing problems resulting from the presence of a limited quantity of water in the airplane fuel system regardless of the

source of such water contamination.

Efficient design and development capability made it possible for AiResearch to build an efficient lightweight bleed air fuel heater system on an expedited schedule of seven month's time from initial order to production delivery. AiResearch has been the world's largest and most experienced manufacturer of aircraft heat transfer systems for 20 years. Outstanding design and production facilities, supported

by extensive laboratory and test equipment, enable AiResearch to quantity-produce fuel heaters of any configuration in minimum time while maintaining rigid quality controls.

In addition to the B-52 fuel heater, AiResearch is also producing several other types of plate and fin air-to-fuel as well as shell and tube oil-to-fuel heaters for both military and commercial aircraft applications. Your inquiries are invited.



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AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS



The care and feeding of a missile system



It takes more than pressing a button to send a giant rocket on its way. Actually, almost as many man-hours go into the design and construction of the support equipment as into the missile itself. A leading factor in the reliability of Douglas missile systems is the company's practice of including all the necessary ground handling units, plus detailed procedures for system utilization and crew training. This complete job allows Douglas missiles like THOR, Nike HERCULES, Nike AJAX and others to move quickly from test to operational status and perform with outstanding dependability. Douglas is seeking qualified engineers and scientists for the design of missiles, space systems and their supporting equipment. Some immediate openings are described on the facing page. Please read it carefully.

Alfred J. Carah, Chief Design Engineer, discusses the ground installation requirements for a series of THOR-boosted space probes with Donald W. Douglas, Jr., President of **DOUGLAS**

MISSILE SYSTEMS ■ SPACE SYSTEMS ■ MILITARY AIRCRAFT ■ JETLINERS ■ CARGO TRANSPORTS ■ AIRCOMB ■ GROUND-HANDLING EQUIPMENT

SAE Members

continued

JOHN J. DEVLIN has become supervisor, project administration section, gas turbine systems, with AiResearch Mfg. Division, Garrett Corp. Previously he was a field sales representative with Solar Aircraft Co.

EUGENE M. ARMSTRONG has become director of customer relations with American Electronics, Inc., Electrical Machinery & Equipment Division. Formerly he was vice-president with Coleman Engineering Co., Inc.

CORWIN D. McLEAN, former research engineer with California Research Corp., has been appointed group supervisor for products research and technical service at their El Segundo Laboratory.

MARCUS W. SAVAGE, former group supervisor with California Research Corp., has become engineering associate at Richmond Laboratory. In this position he will direct a research program on performance aspects of engine lubricants.

C. ALLAN FECHSER has become design engineer, support equipment with Thiokol Chemical Corp. Previously he was a line pilot with the United States Air Force.

THADDEUS M. ALEXANDER has become junior assistant mechanical engineer with the City of Detroit, Department of Street Railway. He was formerly mechanical engineer with the Naval Ordnance Test Station in Pasadena, Calif.

NICHOLAS F. FRISCHHERTZ is now manager of Product Support Section, General Electric Co. He had been manager of spare parts and engine rebuild products, Engine Department of General Electric.

W. WEISS has become mechanical engineer, technical department, with Linale & Weiss S.A. He was formerly a sales engineer, with Cummins Diesel Export Corp.

ROGER H. HARRISON is now project engineer with Boeing Airplane Co., Industrial Products Division. He was formerly project engineer with General Motors Corp., Detroit Diesel Engine Division.

JOHN HERN has become assistant chief engineer in charge of body components with American Motor Products Co. His previous position was sales engineer.

PAUL THOMAS, formerly project engineer with American Motor Products Co., is now assistant chief engineer in charge of chassis components and non-automotive products.

FREDERIC EDWIN FULLER, formerly an engineering specialist with Radioplane Co., is now a technical specialist with Aerojet-General Corp.

ROWLAND M. HUSSEY, JR., formerly assistant project engineer with Wright Aeronautical Division, Curtiss-Wright Corp., is now control evaluation engineer with the Small Aircraft Department, General Electric Co.

TAMMO G. DREWES, formerly a sales engineer with American Brake-blok Division, American Brake Shoe Co., is now representing Peerless Steel Co. in a sales capacity, serving the metal-working industry in the warehousing of tool, alloy, and specialty steel.

ROBERT A. BELL, previously assistant chief engineer with William D. Gibson Co., division of Associated Spring Corp., is now chief engineer with American Spring & Wire Specialty Co.

CLYDE L. PRITCHARD has become an associate research engineer with Boeing Airplane Co. He was formerly an analytical engineer with LeTourneau-Westinghouse Co.

EDWARD J. RUSSEL, formerly a tool and die designer at Burroughs Corp., is now a college graduate trainee in the manufacturing engineering department, Steel Division, Ford Motor Co.

GORDON E. STECK has become supervisor of the mechanical equipment section of production engineering group, O & R Division, Naval Air Station at Alameda. Formerly he was an engineer with Hall-Scott, Inc.

CHARLES L. MOON, formerly assistant engine engineer, is now assistant experimental engineer with the White Motor Co.

WILLIAM JOSEPH SKELLEY, formerly aeronautical design engineer with Fairchild Aircraft Division, is now section leader-power plant, Fairchild Aircraft & Missiles Division, Fairchild Engine and Airplane Co.

NORMAN SARCHIN is now engineering sales representative with Chandler Evans Corp. His former position was field engineer with Wm. R. Whittaker Co., Ltd.

DUANE C. ECKSTEDT, formerly senior engineer with the Martin Co., is now senior design engineer with Lockheed Aircraft Corp., Missile Systems Division.

ABRAHAM I. STERN has become chief design engineer with Stratos Division, Fairchild Engine & Airplane Corp. His former position was supervisor of experimental engineering.

continued



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Electrical and Electronics:

- Control System Analysis & Design
- Antenna & Radome Design
- Radar System Analysis and Design
- Instrumentation
- Equipment Installation
- Test Procedures
- Logic Design
- Power System Design

Mechanical Engineering —

Analysis and Design of the following:

- Servo Units
- Hydraulic Power Systems
- Air Conditioning Systems
- Missile Launcher Systems
- Propulsion Units and Systems
- Auxiliary Power Supplies

Aeronautical Engineering:

- Aerodynamic Design
- Advanced Aerodynamic Study
- Aerodynamic Heating
- Structural Analysis
- Strength Testing
- Dynamic Analysis of Flutter and Vibration
- Aeroelasticity
- Design of Complex Structure
- Trajectory Analysis
- Space Mechanics
- Welding
- Metallurgy

Physics and Mathematics:

- Experimental Thermodynamics
- General Advanced Analysis in all fields
- Computer Application Analysis
- Computer Programming and Analysis
- Mathematical Analysis

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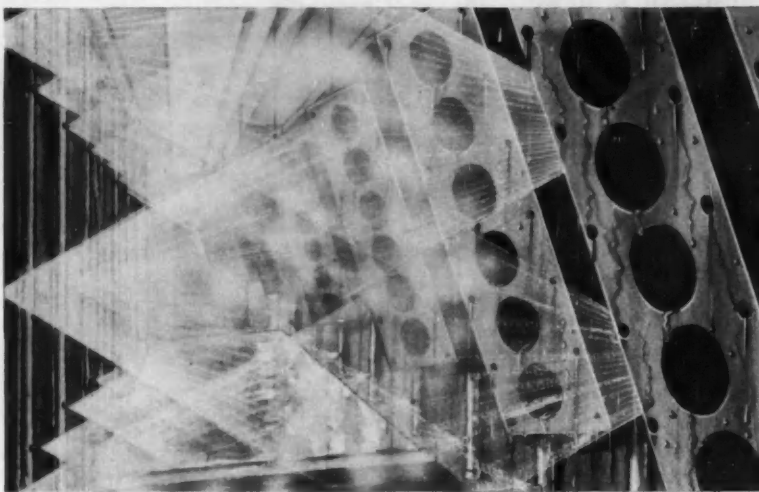
Mr. C. C. LaVene
Box 620-0

Douglas Aircraft Company, Inc.
Santa Monica, Calif.

To get more from your spray washer

ask Oakite

OVER 50 YEARS CLEANING EXPERIENCE • OVER 250 SERVICE MEN • OVER 160 MATERIALS



New Oakite 198 sprays off soils fast . . . protects in-process parts from rust

Users tell us that nothing equals Oakite 198 for cleaning parts in-process. Here's why they think so:

- It clears off heaviest soils at temperatures up to 180° F, and light soils at room temperature.
- Metal chips wash away under its action.
- When dry it leaves a protective film that prevents the rusting of machined or ground parts prior to assembly—yet it doesn't affect accurate gauging.

Now largely used in automotive plants, Oakite 198 is proving its economy as well as its unique effectiveness in providing fast, smut-free cleaning plus rust protection. It works in single or multistage machines, at economical concentrations.

Oakite 198 is just one of a complete line of Oakite materials for machine cleaning. There are non-foaming solvent agents for heaviest duty cleaning, alkaline cleaners for removing moderate to light soils. When you ask Oakite you can be sure of getting a cleaning compound designed to give you best possible results, designed to reduce your "per unit" cost. You can be sure, too, of getting prompt, intelligent in-plant service from your local Oakite man.

Send for Bulletin. Oakite Products, Inc., 24 Rector Street, New York 6, N. Y.

it PAYS to ask Oakite



SAE Members

continued

JOSUE R. PICON retired recently as chief draftsman, patent section, General Motors Corp. Picon has worked in the patent section since he joined General Motors in 1919. He is now in Europe with his wife.

D. R. HEBERT, previously project engineer, sales, Wright Aeronautical Division, Curtiss-Wright Corp., is now eastern territorial sales manager with Cook Electric Co.

NORMAN E. CHRISFIELD has recently become chief production and service engineer with Continental Aviation & Engineering Corp. He was previously section head, production engineering at Fisher Body Division, General Motors Corp.

JAMES L. DeVOLL has joined Ramo-Wooldridge Division of Thompson Ramo Wooldridge, Inc., as electronics engineer. Formerly he was associated with Hughes Aircraft Co. in a similar capacity.

GLEN B. SORENSEN, formerly fleet engineer with Omar, Inc., is now manager of Meeks Rent A Car Co., Omaha Division of Transportation Equipment Rentals, Inc.

RICHARD F. MERRITT has recently become product analyst for General Motors Styling Studios. Formerly he was product planning analyst for Ford Motor Co., M-E-L Division.

S. J. OAKES has become a service engineer with Technical Services Department of Ohio Oil Co. He was formerly a field engineer with Standard Oil Co. of Ohio.

EDWIN C. LOWE, formerly installation engineer with Airsupply Co., Division of Garrett Corp., is now application engineer for Aerol Associates.

NICK A. BIRBILIS has become resident engineer with Lockheed Aircraft Corp. Previously he was systems design engineer with Chance Vought Aircraft, Inc.

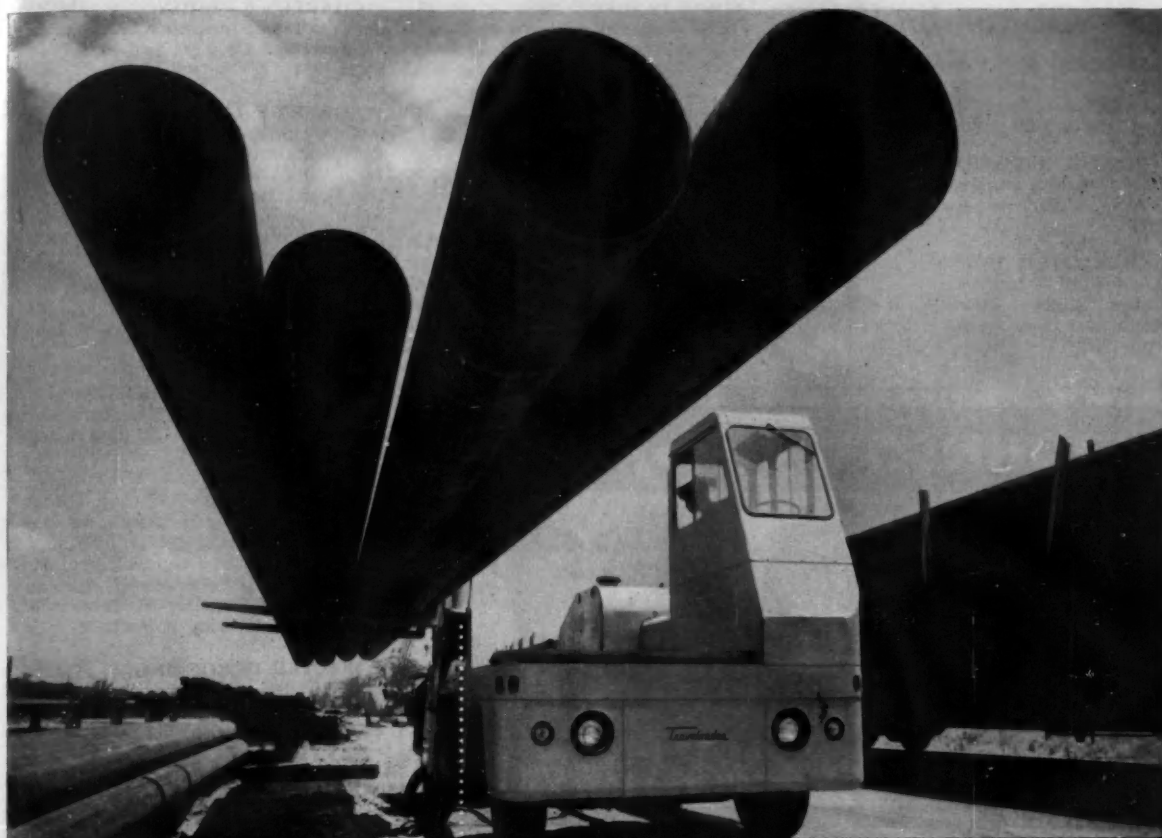
EARL H. KIDD, formerly project engineer with Jacobsen Mfg. Co., has become senior project engineer with the Midland Co., a subsidiary of Outboard Marine Corp.

H. J. BUTTNER, formerly chief engineer with McCulloch Motors Corp., is now engineering consultant, H. J. Buttner & Associates.

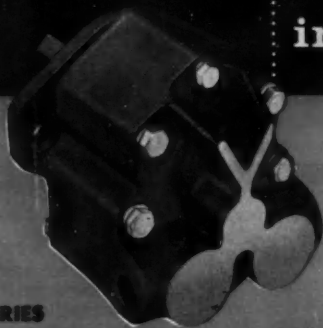
WALTON F. CLARK, formerly a junior mechanical engineer with Gulf Oil Corp., Refinery Technology Laboratory, has become mechanical engineer with Gulf Research & Development Co., Refinery Technology Laboratory.

ARTHUR L. KNIGHT has become shop foreman, new car department with Burkitts Service Station, Inc. Previously he was service foreman with Burkitts.

continued



DYNAMIC DIFFERENCE in hydraulic performance



"HC" SERIES

POSITIVE DISPLACEMENT GEAR-TYPE PUMP

Shaft seal: lip type	Operating speeds: to 2400 rpm
Drive: direct, gear or belt	Porting: side (Std.) and (Opt.)
Capacity: 5 sizes, 5 - 17 gpm	Valve: Optional; internal relief,
Pressures: to 1500 psi	adjustable 800 - 1500 psi

BULLETIN HY11 gives complete engineering characteristics — performance and installation data.

Call the man from Webster

... he's one of a staff of engineers, specially trained in hydraulic application. He can help you solve special problems when hydraulics become a part of your design.



photos Baker Industrial Trucks, div. of Otis Elevator Co., Cleveland, O.

Webster POSITIVE DISPLACEMENT GEAR-TYPE PUMPS

Yesterday's pipe dream is today's nimble-fingered reality. This versatile fork lift truck unloads and stacks — carries a full platform load. The heart of its powerful hydraulic system is a Webster Gear-Type Pump. Just another example of Webster's practical and economical adaptation to hundreds of hydraulic applications... in lift systems, pressure lubricating, oil circulating... in industrial, agricultural and construction equipment.

Webster Gear-Type Pumps present many advantages in design "fit" and application — with unusual standardization and interchangeability of components. Keep Webster in mind when you plan hydraulics — for the dynamic difference that pays!

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

our **50**th year **RACINE · WIS**

Franklin edn. H-113

Obituaries

ARTHUR W. ANDERSON . . . (M '26) . . . sales engineer, Borg & Beck Division, Borg-Warner Corp. . . . died February 23 . . . born 1896.

GEORGE T. CHAPMAN . . . (M '28) . . . designing engineer, Murray-Way Corp. . . . died February 11 . . . born 1893.

SHERMAN R. DONER . . . (M '48) . . . technical representative of Manhattan Rubber Division, Raybestos-Manhattan, Inc. . . . died August 12 . . . born 1902.

LEONIDAS DOTY, JR. . . . (M '39) . . . vice-president in charge of engineering and research for Wausau Motor Parts Co. . . . died June 4 . . . born 1911.

TALTON D. COX . . . (M '58) . . . superintendent of maintenance, R-C Motor Lines, Inc. . . . died April 10 . . . born 1923.

KARL FALK . . . (M '47) . . . design engineer, Hamilton Standard Windsor Locks . . . died May 11 . . . born 1898 . . . also publisher of technical books and author of "Falks Graphical Solutions."

CHARLES E. HERING . . . (M '43) . . . staff assistant to chief engineer, White Motor Co. . . . died May 8 . . . born 1911.

ROBERT F. LYBECK . . . (M '31) . . . retired manager of aviation sales for Esso Standard Oil Co. . . . died August 18 . . . born 1893 . . . also president of the Boston Rotary Club, president of Aeronautic Association of Boston, and a faculty member of Northeastern University's evening division

H. NEIL PALMER . . . (M '11) . . . owner of H. Neil Palmer Co. . . . died March 12 . . . born 1888.

DR. JAMES T. MacKENZIE . . . (M '43) . . . technical director, American Cast Iron Pipe Co. . . . died November 17 . . . born 1891.

ARTHUR S. RANDAK . . . (M '48) . . . assistant eastern division manager of Sinclair Refining Co. . . . died May 5 . . . born 1913 . . . also director of Sinclair Research Laboratories, Inc. and chairman of Sinclair Refining Co.'s motor fuels steering committee.

WALTER H. ROESING . . . (M '53) . . . territory representative with Champion Spark Plug Co. . . . died September 12 . . . born 1900.

CLARENCE K. SENCEBAUGH . . . (M '19) . . . registered professional engineer . . . died in February . . . born 1884.

JOHN T. SHATAGAN . . . (M '42) . . . employed by Chrysler Missile Division, Chrysler Corp. . . . died April 9 . . . born 1898.

HOWARD B. SIMKINS . . . (M '58) . . . design group engineer, Support and Base Facilities, Lockheed Aircraft Corp. . . . died September 28 . . . born 1916.

H. BRIAN STANLEY . . . (M '45) . . . supervising engineer for Hawaiian Pineapple Co.'s Wahiawa Plantation . . . died July 12 . . . born 1904.

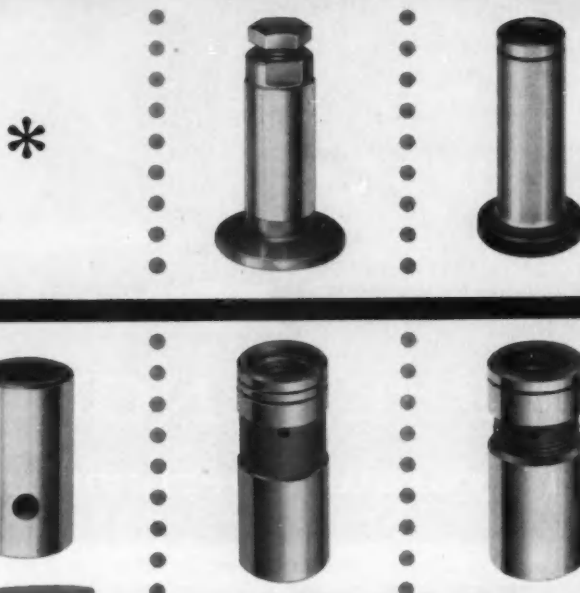
ARTHUR E. STEVENS . . . (M '46) . . . office engineer, State of Ohio, Highway Department . . . died June 1 . . . born 1894.

LOYAL G. TINKLER . . . (M '18) . . . retired metallurgical engineer with Vanadium Corp. of America . . . died May 7 . . . born 1894.

ARTHUR L. TOWNSEND . . . (M '24) . . . retired associate professor of mechanical engineering at Massachusetts Institute of Technology and director of its Lowell Institute School . . . died August 17 . . . born 1892.

JOSEPH TRACY . . . (M '05) . . . rebuilder and scout for antique automobiles, established automotive laboratory for testing cars . . . died March 20 . . . born 1874.

JOHNSON *tappets*



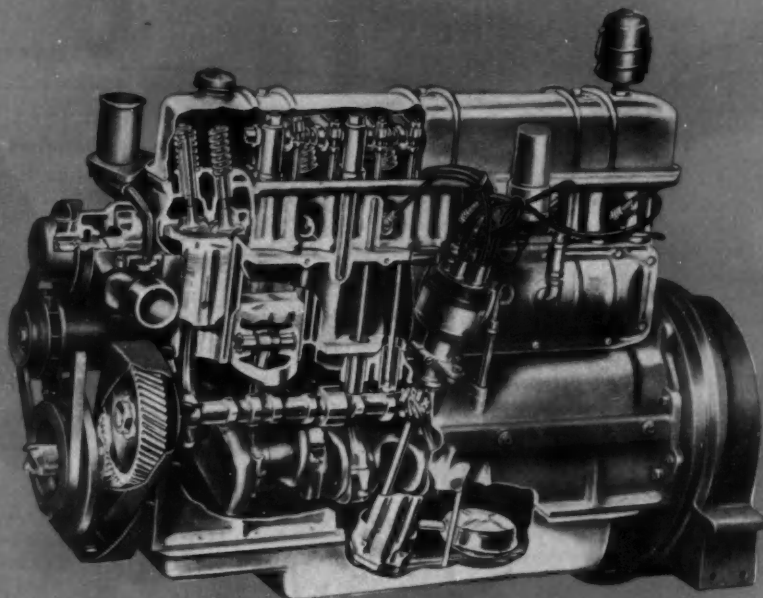
**for all engine applications*

All of the engineering and manufacturing effort at Johnson Products goes into producing a better tappet. Continual experimentation and exacting quality control make JOHNSON TAPPETS worthy of your consideration. Only proven materials, covering a range of hardenable iron, steel, and chilled iron of various alloys, are used in JOHNSON TAPPETS. These tappets are successfully used in jobs ranging from light duty to the most severe, punishing applications. Serving all industry that employs internal combustion engines.



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JOHNSON *Jp* PRODUCTS
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New UB-220 and UB-264 engines have same high quality construction.

New International downdraft 6's give high product power at low cost

Leading equipment manufacturers are finding a variety of applications for new International UB-220 and UB-264 6-cylinder engines with up to 110 and 148 hp. respectively. This immediate acceptance of these dependable heavy-duty engines is due to four factors: 1) high horsepower developed at lowest cost; 2) outstanding field support by dealer service and parts availability; 3) ease of servicing; and 4) minimum maintenance.

Both engines have these common features: valve-in-head design with downdraft carburetion for maximum power with minimum fuel; reinforced crankcase with full-length water jackets; 100% counterbalanced crankshaft for minimum bearing loads at high speeds; aluminum alloy stepped-dome pistons; gear-driven camshaft for high valve lift, quiet operation and minimum wear; full-pressure lubrication through rifle-drilled passages; large intake valves for free in-flow of fuel-air mixtures; long life exhaust valves with rotators and hard seat inserts; 12-volt electrical system; ball-bearing mounted water pump, full flow oil filter, positive crank-

case ventilation with clean air; and easy access to valves, spark plugs, and accessories for simplified maintenance.

For additional product data or any type of installation assistance, call or write International Harvester Co., Engine Sales Dept., Construction Equipment Division, Melrose Park, Ill.



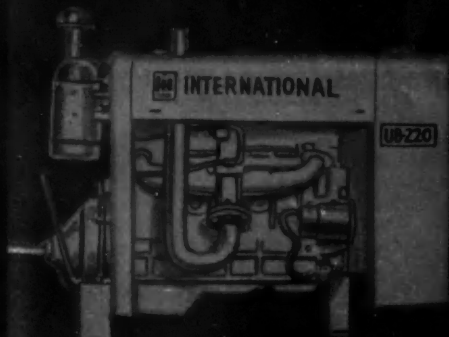
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Equipment**

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A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors... Self-Propelled Scrapers and Bottom-Dump Wagons... Crawler and Rubber-Tired Loaders... Off-Highway Haulers... Diesel and Carbureted Engines... Motor Trucks... Farm Tractors and Equipment.

BRIEF SPECIFICATIONS

Model	UB-220	UB-264
Stripped eng. hp. @ 3400 rpm.	110	148
Indust. eng. hp. @ 2,800 rpm.	83	112
Piston Displ., cu. in.	220.5	264
Bore & Stroke.....	3 $\frac{1}{8}$ x3 $\frac{1}{16}$	3 $\frac{1}{8}$ x4 $\frac{1}{8}$
Compression ratio	7.5:1	7.5:1
Ind. engine wt., complete, lbs.	815	820



UB-220



UB-264



MIDLAND TREADLE VALVES

NEW, IMPROVED MODEL SPEEDS BRAKING TIME

Here's a Treadle Type Foot Control Valve you can't beat for application and release time. Redesigned from beginning to end, it's compact, light, easily adapted to varying installation requirements . . . Trim, modern styling adds a lot to its appearance—and the tread is rubber-capped for extra

safety's sake . . . We'll be glad to give you a demonstration, or furnish a sample for your examination.



MIDLAND-ROSS CORPORATION

**OWOSSO DIVISION,
OWOSSO, MICHIGAN**



ONE OF THE 400 LARGEST AMERICAN CORPORATIONS

continued from page 90

ing. (The fuel is an excellent coolant.)

Storable Propellant Performance

The first storable systems were WFNA/JP-4, and later, IRFNA/JP-4. (See Table 3 for IRFNA performance.) These propellants were abandoned because hypergolic ignition was not reliable, and combustion was unstable.

These difficulties are solved when approximately 40% of UDMH is added to JP-4 . . . UDMH is reliably hypergolic with IRFNA, and also increases performance by 2%.

The fuel mixture 60% UDMH-40% diethylenetriamine (Hydyne) increases performance further — while still maintaining a storable system. IRFNA/Hydyne has wide operational temperature limits, is readily available, cheap, and hypergolic.

However, its performance is still relatively low. If UDMH is substituted for Hydyne, the specific impulse is increased — but not the overall performance (which also depends on the propellant bulk density). In fact, the density impulse obtained with Hydyne is 3% greater than with UDMH.

Hydrogen peroxide has performance levels comparable to IRFNA, although it has limited storability — and merits consideration when only short storage times are required.

If N_2O_4 is substituted for IRFNA, fuel specific impulse is increased 3.2%, but density impulse decreases 2-4%.

In general, propellant systems utilizing mixed oxides are relatively high performing, cheap, compatible with mild steel, and hypergolic — but there is a high oxidizer vapor pressure and decreased density impulse.

The specific impulse of ClF_3 is less than that obtained with N_2O_4 (except with hydrazine), but the density impulse is 16% greater. It is thus an excellent oxidizer in terms of performance, density, hypergolicity, and low freezing point when used with amine- or hydrazine-based fuels. Its performance is low with hydrocarbons.

▲ To Order Paper No. 59R . . . on which this article is based, see p. 6.

New Air Force Policy Spends Dollars for Force

Based on report by secretary

R. J. McELLIGOTT

General Electric Co.

THE relationship between the U. S. Air Force and its prime contractors is changing. The new Air Force policy is to spend its fiscal appropriations for force-in-being rather than to invest in long-range capital equipment. This

Continued



A NOTABLE NEW HIGH-TEMPERATURE GRAPHITE for mechanical uses

When mechanical applications call for a material having low friction and low wear rates at temperatures where ordinary graphite and even many metals fail, Stackpole Grade 469 high-temperature graphite may well be the answer. Typical applications include extensive use as main bearing oil seals on turbo-prop engines and as bearing inserts in turbine blade pitch adjusting mechanisms.

A special treatment that inhibits oxidation assures maximum performance between 1000° and 1200° F. and will not "bleed out." The material is also good at lower temperatures.

Grade 469 is self-lubricating, will not seize or fuse and is unaffected by most chemicals and gases. Transverse strength is better than average. It is supplied in blanks or finished pieces or as bearings press-fitted into stainless steel housings.

Hundreds of other low-cost Stackpole carbon and graphite materials are likewise available. Send details of your application for suitable grade recommendation.

STACKPOLE CARBON CO., St. Marys, Pa.

STACKPOLE



BRUSHES for all rotating electrical equipment • COMPOSITION ELECTRICAL CONTACTS • BEARINGS • SEAL RINGS • VOLTAGE REGULATOR DISCS • MOLDS & DIES • FRICTION SEGMENTS • CORROSION CONTROL RODS • HEATING ELEMENTS • CHEMICAL ANODES • BRAZING BOATS • WELDING CARBONS . . . and many other carbon, graphite and metal powder products.



McLouth Steel Corporation

HOT AND COLD ROLLED SHEET AND STRIP STEELS
Detroit 17, Michigan

approach is designed to make dollars pay off as fast as possible rather than to invest in further plant expansions.

To implement the policy, it is necessary to utilize the broadest possible industry base with competition insuring that the most value to the nation will be achieved at the lowest cost.

As another feature, the Air Force is examining and applying more incentive profit features in their buying activities to further assure minimum cost for maximum force. Hardware, not facilities, will obtain the bulk of the Air Force dollar in the future. Since the Air Force believes much, if not all, of the required skills and equipment presently exist in industry, it is necessary that manufacturing be spread across the broadest possible base and not be concentrated with a relatively few prime contractors.

Naturally, the Air Force realizes that private industry will not provide and underwrite all facility requirements of the future. However, it is expected that in contract negotiations there will be a greater give and take with much more emphasis placed on the amount of facility investment provided by the prime contractor.

Any facility requests will require the most careful documentation. The Air Force expects to only provide those facilities of limited use and special nature that would not be accepted by private capital for investment.

Through prime contractors seeking out the skills and facilities of industry, it is expected that competition will enable industry to renew itself and have available those facilities of a general nature, thereby allowing the Air Force to have more dollars to spend for hardware out of its fiscal budget. This is becoming of increasing concern to the Air Force in these times of rising costs and tight monetary controls. On cost protected type contracts, the Air Force does, and will continue to, look over management's shoulders to assure that its policies are being implemented. This is not to be construed as interference with private management, but rather assistance to management in the economic use of the Air Force resources.

Serving on the panel which developed the information in this article, in addition to the panel secretary, were: Paul Nichols, General Electric Co.; R. C. Cole, Bendix Aviation Corp.; S. E. G. Hillman, General Dynamics Corp.; S. Langner, Fairchild Engine and Airplane Corp.; Col. I. H. Larkey, U. S. Air Force; L. C. Leavitt, Otto Konigslow Mfg. Co.; and K. Weddell, Office of Small Business, U. S. Air Force.

(This article is based on a secretary's report of a production panel entitled "Make or Buy". This report—along with 6 other secretaries' reports on various production subjects—is available in multilith form as SP-327. See order blank on p. 6.)

What It Means To Be an Executive

Based on talk by

K. E. KINGMAN

Union Oil Co.

(Presented before SAE Southern California Section)

MAKING decisions and getting things done are the basic functions of the executive. Decisions must be made so

that the right, or best, course of action will be followed. Then the chosen action must be accomplished.

The executive may have the responsibility to make a decision without having the obligation to carry out the action required by the decision. Or he may have the obligation to get something done without having had the responsibility for the decision which requires the action. In either case, whether making a decision to do something, or carrying out the action required by his own or another's decision,

Continued

ROCKFORD



MORLIFE® CLUTCHES

Insure SMOOTH Powerful Pick-Up in Heaviest Going

Compared to previous type friction plates, Morlife® Clutches reduce foot pedal pressure up to 50%. They assure positive engagement—with power-holding grip. Provide a degree of heat resistance and dissipation never before available. They give several times the durability for prolonging clutch life and extend the time between pedal adjustments many times as long.

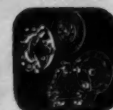
See us in Booths No. 5-1 to 5-16 at
the Milwaukee S.A.E. Convention

SEND FOR THIS HANDY BULLETIN
Gives dimensions, capacity tables and complete specifications. Suggests typical applications.

ROCKFORD Clutch Division BORG-WARNER

316 Catherine St., Rockford, Ill., U.S.A.
Export Sales Borg-Warner International — 36 So. Wabash, Chicago 3, Ill.

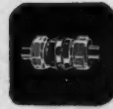
CLUTCHES



Small
Spring Loaded



Heavy Duty
Spring Loaded



Oil or Dry
Multiple Disc



Heavy Duty
Over Center



Power
Take-Offs



Speed
Reducers

2 NEW! STRATOFLEX HYDRAULIC COUPLINGS



**QUICK
DISCONNECT**

Thanks to non-metallic seals, the new Stratoflex all-purpose couplings guarantee a positive self-sealing unit when connected or disconnected. When the two halves are connected, the valves open automatically to assure maximum flow, with a minimum of pressure drop.

Stratoflex Self-Sealing Couplings are available in three designs: wing nut, hex nut and knurl sleeve, with NPTF Pipe Thread or SAE "O"-Ring Boss Thread, in sizes ranging from 1/4" to 1 1/4".

Stratoflex Quick-Disconnect Couplings are furnished in NPTF Pipe Thread and SAE "O"-Ring Boss Thread, with a size range from 1/4" to 1".

For complete information on Stratoflex Hydraulic Couplings, write for Stratoflex Bulletin S-7 immediately.



**SELF
SEALING**

SFB-9

STRATOFLEX Inc.
P.O. Box 10398 • Fort Worth, Texas
Branch Plants: Los Angeles, Fort Wayne, Toronto
In Canada: Stratoflex of Canada, Inc.

SALES OFFICES:
Atlanta, Chicago
Cleveland, Dayton
Detroit, Fort Wayne
Fort Worth
Houston, Kansas City
Los Angeles, Milwaukee
New York, Philadelphia
Pittsburgh
San Francisco, Seattle
Toronto, Tulsa

the responsibility rests with the executive. He is responsible for the results from decision and the results from action. He may delegate authority to carry out action, but he cannot delegate the responsibility for decision or the results of action.

An executive must have courage. Courage is necessary to do anything when you realize the results of your action contain a considerable element of risk, that they may be unpleasant or distasteful, and that they are important. It takes courage to make an executive decision when you realize that making the right one may mean dollars to your company and affect many people in your organization.

The question "Do you want to be an executive?" then breaks down into three questions: do you want to make decisions, do you want to get things done, are you willing to accept the responsibility for decisions and actions?

Consumer Wants Not Always His Needs

Based on talk by

SUMNER RICE

Johnson Motors Division, Outboard Marine Corp.

(Presented before SAE Southern New England Section)

OPEN-MINDED engineering — engineering keyed to what the consumer wants and needs — calls for close association with the sales department and its market research tools.

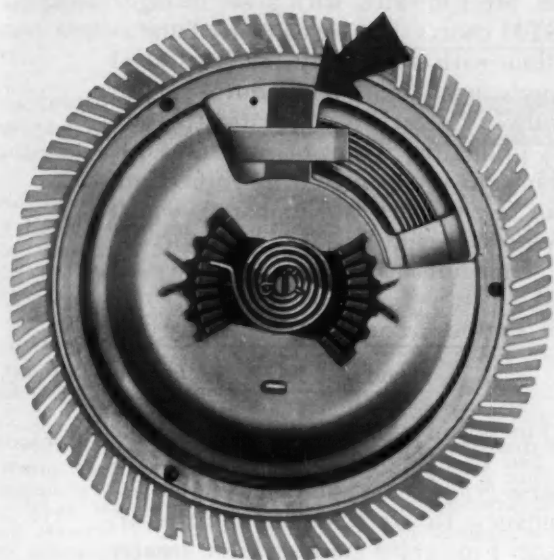
The customer does not always know what he needs, although most of the time he seems to know what he wants. The first task, therefore, is to find out what is wanted. Those data, interpreted in the light of experience and judgment, often transpose statements of expressed wants into a determination of actual needs.

The consumer, for example, says he wants hotter (or colder) spark plugs to avoid fouling, when what he really means is that he needs a faster warmup in very cold water. His usage and location data tell that story. He needs thermostatic control of the cooling system. He may express his want for more power when proper evaluation indicates this is really an expression of a need for a refinement having little or nothing to do with power.

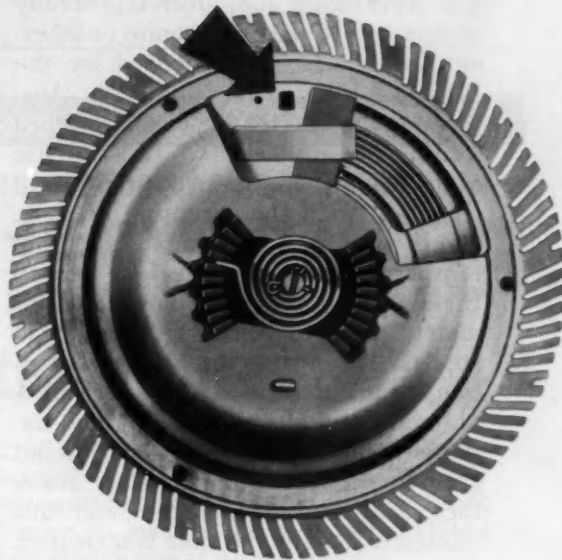
Open-minded engineering reduces the problem of determining these needs tremendously, since it provides the sympathetic background necessary to a thorough understanding of them. This background is most helpful in analyzing correctly the warranty service returns. Here, correct analysis effects substantial savings in money and, even more important, savings in engineering man-hours, which are irreplaceable.

NOW — a New Temperature Sensitive EATON VISCO-DRIVE

— a Thermostatically Controlled Fan Drive that Increases Usable Horsepower and Reduces Fan Noise



WHEN COOLING IS NOT REQUIRED: The fan idles when under-hood temperature is below the thermostatic setting. The slide-valve is closed preventing fluid from entering the viscous-drive chamber.

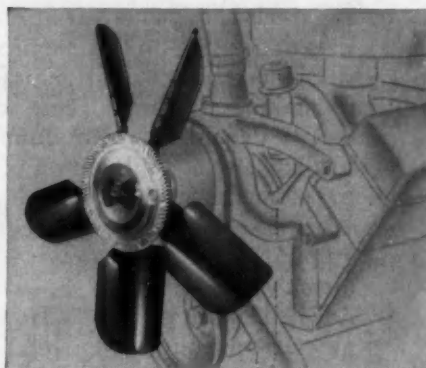


WHEN COOLING IS REQUIRED: Fan speed increases with rise in under-hood temperature. Thermostatically controlled slide-valve regulates the amount of fluid entering the drive chamber, increasing fan rpm accordingly.

The new Eaton Visco-Drive is automatically regulated by under-hood temperature. As under-hood temperature rises, the Visco-Drive automatically increases fan rpm to produce required cooling. Operational ranges can be established to suit the requirements of each vehicle model.

Thermostatically-modulated fan operation increases net output of engine when cooling is not needed; permits designing for greater cooling efficiency at low engine speeds without the disadvantage of fan noise at high speeds.

The Eaton Visco-Drive is of simple, functional design and light-in-weight construction. Field and laboratory tests have proven its dependability for application on all types of vehicles.



Ultra-compact design makes the Visco-Drive readily adaptable to your present installation with only minor changes.

*Torque-Sensitive Eaton Visco-Drives are also Available.
Consult with Our Engineers on Your Fan Drive Needs.*



EATON

**PUMP DIVISION
MANUFACTURING COMPANY**
9771 FRENCH ROAD • DETROIT 13, MICHIGAN



KNOW YOUR ALLOY STEELS . . .

This is the third of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

What Does Grain Size Mean In An Alloy Steel?

The grain size of alloy steels is generally understood to mean austenite or inherent grain size, as indicated by the McQuaid-Ehn carburizing test. Austenite grain size should be distinguished from ferrite grain size, which is the size of the grains in the as-rolled or as-forged condition with the exception of those steels that are austenitic at room temperature. When steel is heated through the critical range (approximately 1350 to 1600 deg F for most steels, depending on the composition), transformation to austenite takes place. The austenite grains are extremely small when first formed, but grow in size as the temperature above the critical range is increased, and, to a limited extent, as the time is increased. It is apparent, therefore, that both time and temperature must be constant in order to obtain reproducible results.

When temperatures are raised materially above the critical range, different steels show wide variations in grain size, depending on the chemical composition and the deoxidation practice used in making the heat. Heats are customarily deoxidized with aluminum, ferrosilicon, or a combination of deoxidizing elements. Steels using aluminum or other deoxidizers in carefully controlled amounts maintain a slow rate of grain growth at 1700 deg F, while heats finished with other deoxidizers, usually ferrosilicon, develop relatively large austenite grain size at temperatures somewhat below 1700 deg F.

The McQuaid-Ehn test is the one ordinarily used for determining grain

size. Steel is rated with a set of eight ASTM charts that are compared one at a time with a specially prepared steel sample until one is found to match. Number 1 grain size, the coarsest, shows $1\frac{1}{2}$ grains per sq in. of steel area examined at 100 diameters magnification. The finest chart is Number 8, which shows 96 or more grains per sq in. at the same magnification.

Properties Affected by Grain Size

Fine-grain steels (grain sizes 5, 6, 7, and 8) do not harden as deeply as coarse-grain steels, and they have less tendency to crack during heat-treatment. Fine-grain steels exhibit greater toughness and shock-resistance—properties that make them suitable for applications involving moving loads and high impact. Practically all alloy steels are produced with fine-grain structures.

Coarse-grain steels exhibit definite machining superiority. For this reason a few parts which are intricately machined are made to coarse-grain practice.

The correct specification and determination of grain structure in steel is a subject that has been given long study by Bethlehem metallurgists. If you would like suggestions on this or any other problem concerning alloy steels, these men will be glad to give you all possible help.

In addition to the entire range of AISI alloy steels, Bethlehem produces special-analysis steels and the full range of carbon grades.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL



Ther
and A
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Albert
D. H

Atlanta
Capt
(M).

British
Will
MacQu

Buffalo
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Central
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Chicago
Way
Johan
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ward
(M), K
Sholts
Richar

Cincinnati
Rog

Cleveland
Will
Graham
Wilfrid
Kerske
Harry
Retar

Colorado
Balt
Giersd

Dayton
Will

Detroit
Roy
(M), J
Brand
M. C
Hadda
Owen
Konta
R. Lip
Ira W
Lloyd
Ragaz
Lee T
Willia

SAE JO

New Members Qualified

These applicants qualified for admission to the Society between July 10, 1959 and August 10, 1959. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Alberta Group

D. H. Pugsley (M).

Atlanta Section

Capt. Charles M. Thomas (Retired) (M).

British Columbia Section

William J. K. Gibson (M), Lewis W. MacQueen (A).

Buffalo Section

Ralph F. Barth (M), Ralph C. Mangold (M), Charles N. Moore (M), Ronald James O'Mara (J), Fredric C. Ryan (M).

Central Illinois Section

John H. Altorfer (A), Albert Edward Rust (M), Chester P. Swan (M).

Chicago Section

Wayne Allen Hennig (J), Donald D. Johannesen (J), Walter P. Kushmuk (M), Louis Magazanik (A), John Edward Mazanet (J), Robert C. Miller (M), Richard H. Nulf (J), Richard A. Sholts (J), William L. Sieker (M), Richard Warrington (A).

Cincinnati Section

Roger Walmsley (A).

Cleveland Section

William E. Foster (A), Gilbert Harold Graham (A), James M. Hooper (M), Wilfrid Stanley Johnston (M), T. M. Kersker (M), William D. Mathers (M), Harry Ralph Neifert (M), John A. Retar (M).

Colorado Group

Balthasar T. Bollig (A), Galen O. Giersdorf (A), R. Dewey Rinehart (M).

Dayton Section

William T. Condon (M).

Detroit Section

Roy F. Abell, Jr. (J), Cecil S. Allen (M), John M. Beamish (M), Robert W. Brandt (J), Walter F. Brown (A), Ben M. Callaway (J), Mitchell Joseph Haddad (M), Charles A. Jones (J), Owen F. Keeler, Jr. (M), Rolland E. Kontak (J), Hans E. Kutscher (A), H. R. Lippert (M), Donald G. Martus (M), Ira W. Nichol (M), John Pankow (J), Lloyd Erwin Peters (M), Alfredo R. Ragazzi (J), Ron Rohloff (A), Allan Lee Turner (J), Fred Wallace Uhl (M), William Waite (M).

Fort Wayne Section

Lester M. Harlan (M), Miss Bonnie J. Marschand (M), Charles A. Pickett (J).

Hawaii Section

Douglas Craddick (A).

Indiana Section

James T. Baker (M), Harold F. Brown (M), Harry B. Hart (M), Wm. P. Henson (M), K. H. Hoffman (M), Joseph Arthur Keirans (M), Wilford Eugene Smith (M), Wayne H. Vande Steeg (M).

Kansas City Section

Richard E. Brecko (M), Darrel L.

Continued

It Could Be Done... so "WISCONSIN" Did It!

Now Presenting the Engine Industry's First Line of **HEAVY-DUTY VERTICAL-SHAFT ENGINES**

The Need: During the past few years, vertical-shaft engines have become a part and parcel of "competitive footbaling" in the rotary power-mower field. Because so many of these mowers have been offered at "bargain basement" prices, the quality of the power components had to suffer... to the eventual misfortune of the user-customer.

The Remedy: To meet the demand among discriminating original equipment manufacturers for TOP-QUALITY engines to match their machines, "Wisconsin" has developed and now presents the Industry's first line of truly HEAVY-DUTY, quality-built vertical-shaft power units, in a highly selective power range. Available in three sizes, rated from 2.5 to 9.2 hp. in a 1600- to 3600-rpm range, these rugged, low-silhouette engines have been designed to meet a broad diversity of applications, delivering higher power and service potential.



HOW CAN
YOU
USE IT?

All traditional Wisconsin heavy-duty features are incorporated in the design and construction of these new engines. If you are looking for this type of power unit, let Wisconsin engineers help you adapt these engines to your equipment. For a quick briefing on the WISCONSIN Vertical-Shaft Engine line, write for bulletin S-245.

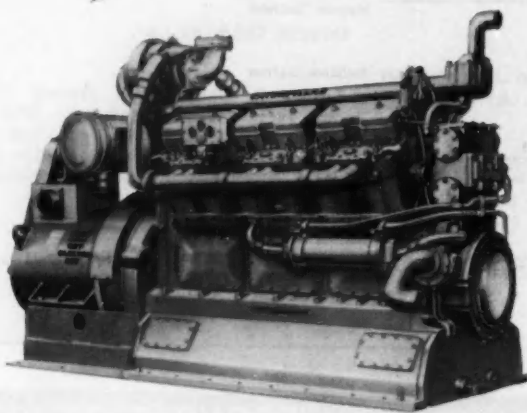


WISCONSIN MOTOR CORPORATION

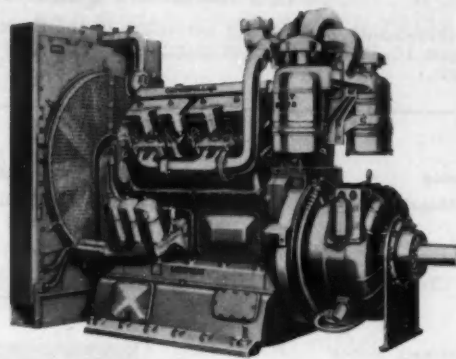
MILWAUKEE 46, WISCONSIN

World's Largest Builders of Heavy-Duty Air-Cooled Engines

AD-6308

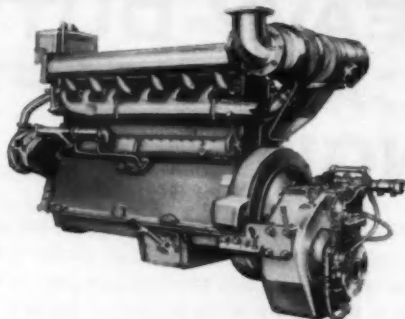


Caterpillar D397 Series D Electric Set

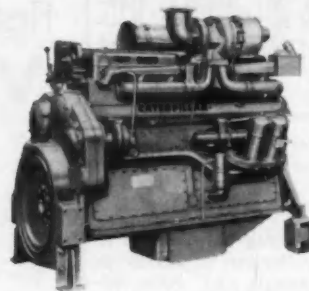


Caterpillar D3751 Series D Industrial Engine, Torque Converter Power Unit

AIRESARCH TURBOCHARGER SYSTEMS



Caterpillar D342 Series C Marine Engine



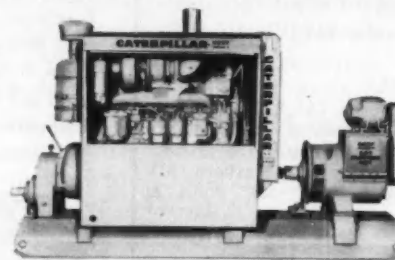
Caterpillar D353 Series C1 Industrial Engine

DESIGNED FOR CATERPILLAR ENGINES

Through the close cooperation of AiResearch and Caterpillar, advanced turbocharger systems have been developed to match each of these production diesel engines covering a wide range of horsepower and applications.

Engine horsepower has been substantially increased to meet higher power demands without penalty of larger size and more weight. For example, the intermittent 415 H.P. Caterpillar D397 industrial engine has been turbocharged to 575 intermittent H.P. (650 H.P. maximum) ... 200 intermittent H.P. Caterpillar D342 industrial engine turbocharged to 260 intermittent H.P. (320 H.P. maximum).

Other important advantages of the AiResearch air-cooled turbochargers: increased horsepower to sea level rating ... lower specific fuel consumption ... less smoking and noise ... cleaner and cooler running engine ... reduced maintenance costs.



Caterpillar D337 Series F Mechanical-Electrical Engine

These advanced turbocharger systems underwent thousands of test hours on the job by Caterpillar and are now in quantity production.

AiResearch is the most experienced company in the design, development and production of small turbomachinery. We will be happy to discuss turbocharger applications for your equipment.



AiResearch Industrial Division

9225 South Aviation Blvd., Los Angeles 45, California

DESIGNERS AND MANUFACTURERS OF TURBOCHARGERS AND SPECIALIZED INDUSTRIAL PRODUCTS

New Members Qualified . . . continued

Bryan (M), Ivan Gilbert Divelbiss (J).

Metropolitan Section

Nicholas P. Cassisi (A), Leslie d'Avigdor (A), William G. Dukek, Jr. (M), George A. Finn (M), Pierre John Haan (J), Edward V. McAssey (M), John D. Rugge, Jr. (A), Harry P. Schmidt, Jr. (M), Paul M. Steginsky (J), Dan S. Tilden (M).

Mid-Michigan Section

George W. Benjamin (A), Ernest M. Plant, II (J), John R. Trcka (J).

Milwaukee Section

I. F. Herbes (M), Robert A. Lofy (M), Roy J. Rauchle (J), John F. Schaefer (M), James J. Sicotte (M), William Van Werkhoven (M), Daniel J. Wahlen (M).

Montreal Section

James Henry Crook (A), Gordon Thomas Keys (A), Lawrence George Mallett (M), John Edward Taylor (A).

New England Section

Thomas E. DeMont (A), Robert E. FitzGerald (M), Newton B. Perkins (A).

Northern California Section

Roger Horner (A), Thomas E. Leonard (M), Gene D. Schott (M).

Ontario Section

William Howard Brokenshire (M), Colin Campbell (M), William Raymond Chapman (A), Donald C. Hubble (M), James Joseph Taylor (A), Norman E. Thompson (A), Derek James Wheeler (A).

Oregon Section

M. Hamer Phillips (A).

Philadelphia Section

Kazimierz Korsak (M).

Pittsburgh Section

William R. Hartman (M).

Rockford-Beloit Section

L. Robert Goldsworthy (M), Richard G. Klein (J), Joseph F. Pech (M).

Salt Lake Group

Guenter Kammer (J).

South Texas Group

John W. Brooks (A).

Southern California Section

Dennis Eugene Bowman (J), Karl T. Edwards (M), A. Gray Fellows (A).

Donald R. Riccio (J)

Spokane-Intermountain Section

Fred N. Bock (A), J. E. McKay (A).

Syracuse Section

Edward W. Fisher (M).

Texas Section

Robert Walter Burden (M), Richard Whipp (A).

Continued



New Members Qualified

Continued

Texas Gulf Coast Section
R. L. Roshong (M).

Twin City Section
Walter William Klausler (M).

Washington Section

Gabriel D. Boehler (M), Richard H. Hawkes (M), Jack Norton (M), Robert B. Reichert (A), Thomas E. Weber (J).

Western Michigan Section

Lloyd Jones, Jr. (M).

Williamsport Group

Kenneth B. Lawrence (M).

Outside Section Territory

Lynn C. Brendel (A), Paul Neher

(M), Newton N. Sacks (M).

Foreign

Norman Charles Gardener (J), England; S. Venkatachalam (J), India; Kenneth Pearce Wakefield (M), England; William Burton Watkins (M), New Zealand.

Applications Received

The applications for membership received between July 10, 1959 and August 10, 1959 are listed below.

Atlanta Section

John Roger Powers, Terry Alfred Rush, Omar Haldene Waters

British Columbia Section

John Clifford Stainsby, David Murray Stewart

Buffalo Section

Clarence Roy Little

Chicago Section

David L. Anthony, Earl Douglas Grange, Leonard D. Lloyd, Poul J. Olsen, Paul H. Seibert, Oliver King Tyler, Rouholah Zargarpur

Cleveland Section

Wayne Robert Brown, Edward J. Cole, Joseph C. Craig, James Bayard Foulk, Wilbur R. Meridith III, Charles L. St. Clair

Dayton Section

G. William Beck, Jack D. Cyrus, Jon Elwood Miller, David L. Ritchey, Arthur J. Stilwell

Detroit Section

Norman R. Benham, Richard Reinhold Born, Joel G. Bussell, Gordon C. Cherry, Dale E. Dawkins, Robert F. Dean, George Franklin Hill, David Byron Jones, Orron E. Kee, Charles L. Klee, Gerald T. Kozlow, Robert W. McMinn, David Richard Moore, Joseph Nagy, Jr., Edward A. Nicol, Patrick Barry Niland John R. Nyland, Eugene V. Renaud, Frank George Rising, John Eugene Schmitt, Lawrence J. Vandenberg, Edgar I. Wylie

Fort Wayne Section

Harry Elwood Blosser, William D. Kreider, Richard Segal, Robert T. Seifert

Continued on page 131

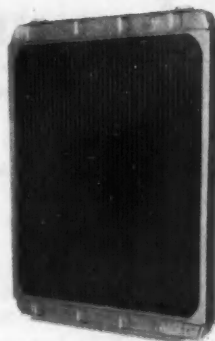
SAE JOURNAL, SEPTEMBER, 1959



Young Radiator cools Engine Jacket Water for High-Powered Diesels

These powerful White tractors pull refrigerated trailers cross country. Rugged terrain and torrid deserts are taken in stride by these rugged Young Radiators. Our Light-Weight Stamped Tank Radiators are specially fabricated, and have exclusive Double Lock-Seam construction. Electronic lock-soldering of headers and tubes provide a more positive, surer construction and a stronger radiator . . . takes more stress . . . gives longer service than radiators unable to offer these features. Write or phone Young to discuss your Heat Transfer problems. No obligations, of course.

"Young Radiators are used where the going is tough!"

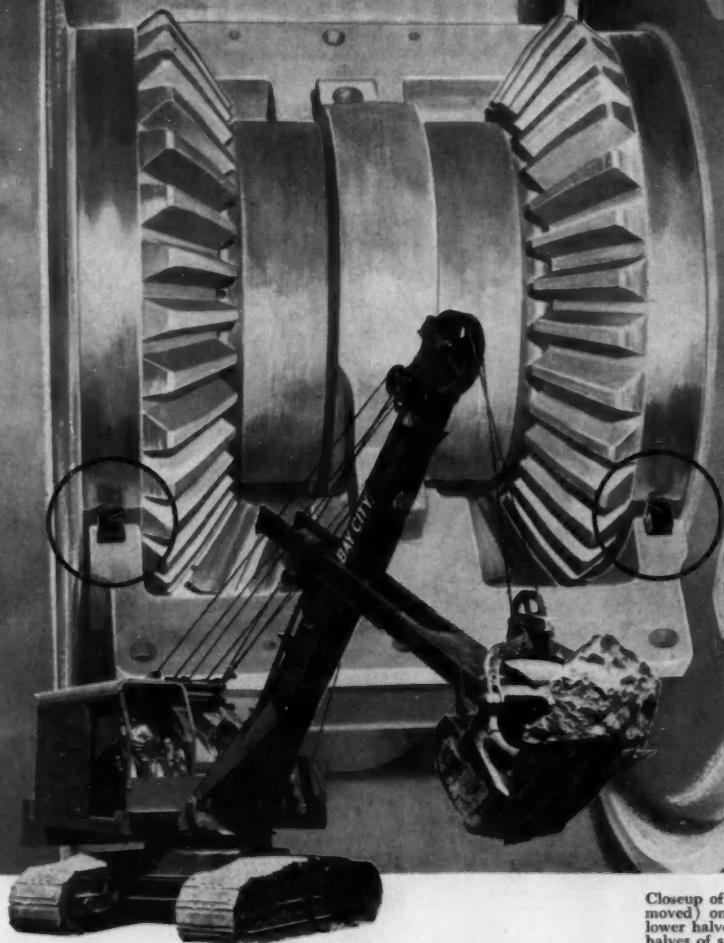


Young radiators have extra built-in strength



Write Dept. 119-J for Catalog 148A.

MORE OF THE GARLOCK **2,000**



Closeup of bevel gear housing (cover removed) on Bay City Shovel. Circled are lower halves of KLOZURE Oil Seals. Upper halves of seals are in gear housing cover.

Easy to Service . . . on the job thanks to Garlock Split KLOZURE* Oil Seals

For the past 10 years, Bay City Shovels, Inc., Bay City, Michigan, has specified Garlock KLOZURE Oil Seals for all types of sealing operations. Specific examples are the two Garlock Split KLOZURES used in the Horizontal swing shaft assembly of all Bay City Power Cranes & Shovels. These seals are furnished in two halves, assembled in grooves, and held in place by axial compression of the cover plate. They operate at 250-300°F. keeping oil in the bevel gear box and keeping dirt out.

There are good reasons why Bay City specifies Garlock Split KLOZURES for this application. Split KLOZURES are easy to replace on-the-job . . . an important requirement for seals used in heavy equipment. They save time and money by eliminating the costly "down-time" operations of dismantling, removing heavy shafts, bearings, gears and couplings.

Garlock Split KLOZURES are important members of "the famous Garlock 2000"—two thousand styles of packings, gaskets and seals for every need. If you have a sealing problem . . . call your Garlock representative for his unbiased recommendation. Or, write for new KLOZURE Catalog 30.

*Registered Trademark

THE GARLOCK PACKING COMPANY, PALMYRA, N. Y.

For Prompt Service, Contact one of our 26 Sales Offices and Warehouses throughout the U. S. and Canada.

GARLOCK



Packings, Gaskets, Oil Seals, Mechanical Seals,
Molded and Extruded Rubber, Plastic Products

Canadian Division: The Garlock Packing Co. of Canada Ltd.

Plastics Division: United States Gasket Co.

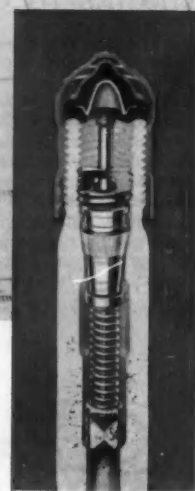


The Garlock Split KLOZURE is ideal for medium speed service for installation without disassembly of equipment. Its unique synthetic sealing material is non-abrasive, free-running; resistant to oil, grease, heat and cold; impervious to water, mild acids and alkalis.

The American Automotive Industry—the world's **Outstanding tire valve** *per*



*Schrader's famous tire valve operating principle
is the ace of standardization
for pneumatic tire-equipped vehicles everywhere*



s greatest enterprise—depends on tire accomplishments
 ve performance matches tires
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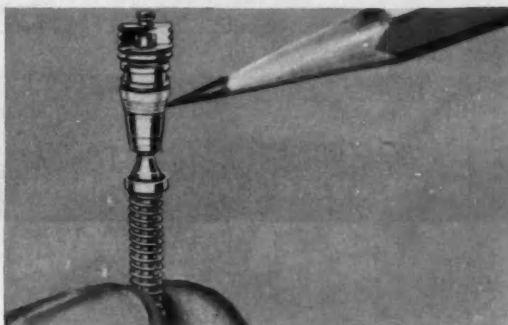
AVAILABILITY. Schrader Tire Valves and service tools follow American vehicles to every corner of the earth, making service fast, easy, universal.



SIMPLICITY UNDERSTOOD. Schrader's system of valve interchangeability works, because American engineering is based on simplicity that speaks a universal language.



INTERCHANGEABLE. Wherever tires are serviced, stocks of Schrader replacement valves are on hand to help every tire deliver full mileage.



QUALITY FIRST. One indication of the success of Schrader's Ace of Standardization is that tire valve performance is taken for granted the world over.

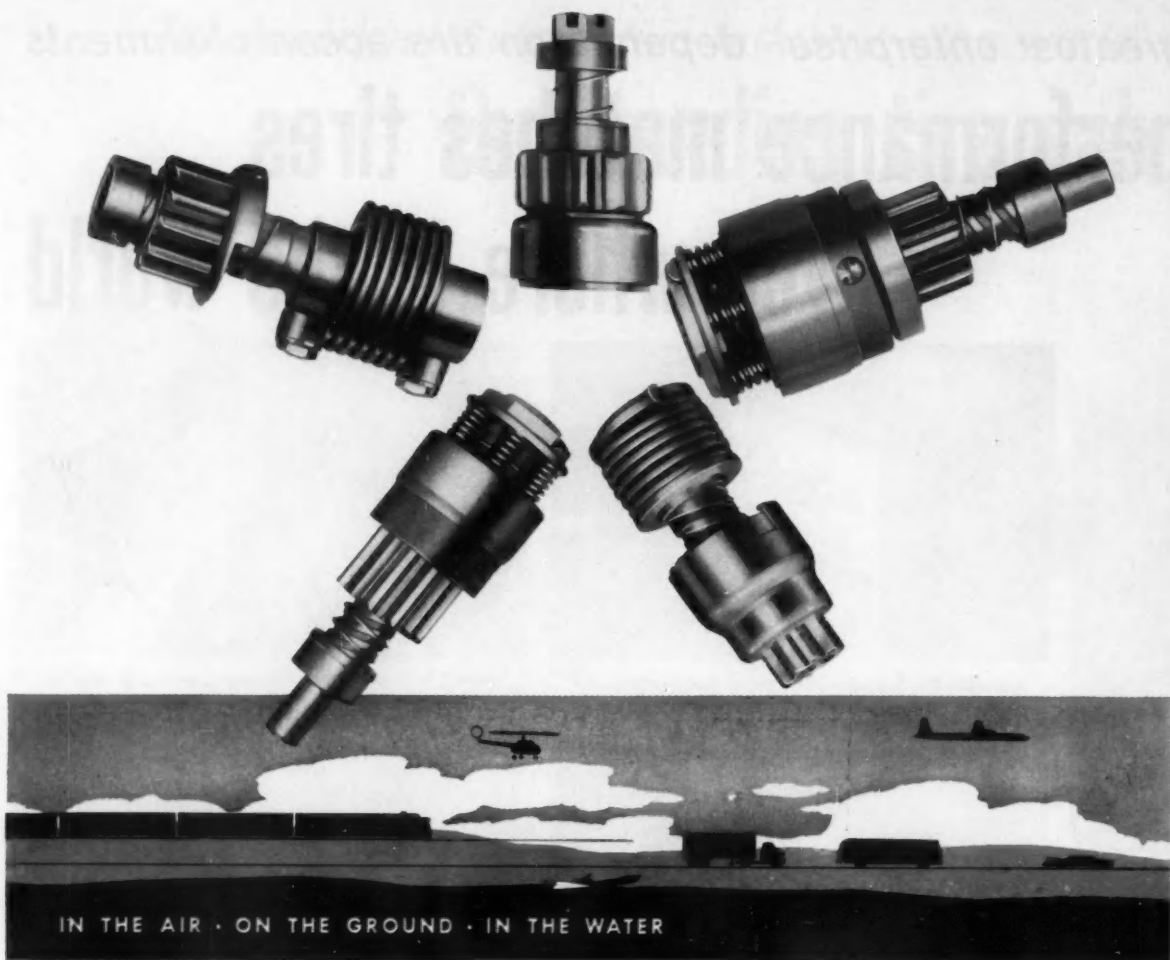
There's excellent reason why the American automotive and tire markets circle the globe. No other industry in history has approached the quality and dependability of its mass-produced products. For example, only a complex of highly specialized companies, *working together*, drawing upon their combined skills, information and facilities, could have developed the modern tire and tire valve that has performed on every vehicle that has ever travelled. You can count on Schrader to produce the quality tire valves to match the performance of your present and future vehicles, wherever they travel.

Schrader
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FIRST NAME IN TIRE VALVES

FOR ORIGINAL EQUIPMENT AND REPLACEMENT



YOU START BETTER WITH BENDIX STARTER DRIVES

For nearly fifty years—and in well over 125,000,000 installations—Bendix* Starter Drives have become the accepted standard for automotive vehicles. Not so well known perhaps—but equally important—is the fact that these units are also first choice for aircraft, locomotives, earth movers, inboard and outboard marine engines. In short, whatever the type of internal-combustion engine, you can start it *better* with a Bendix Drive.

*REG. U. S. PAT. OFF.

Bendix-Elmira

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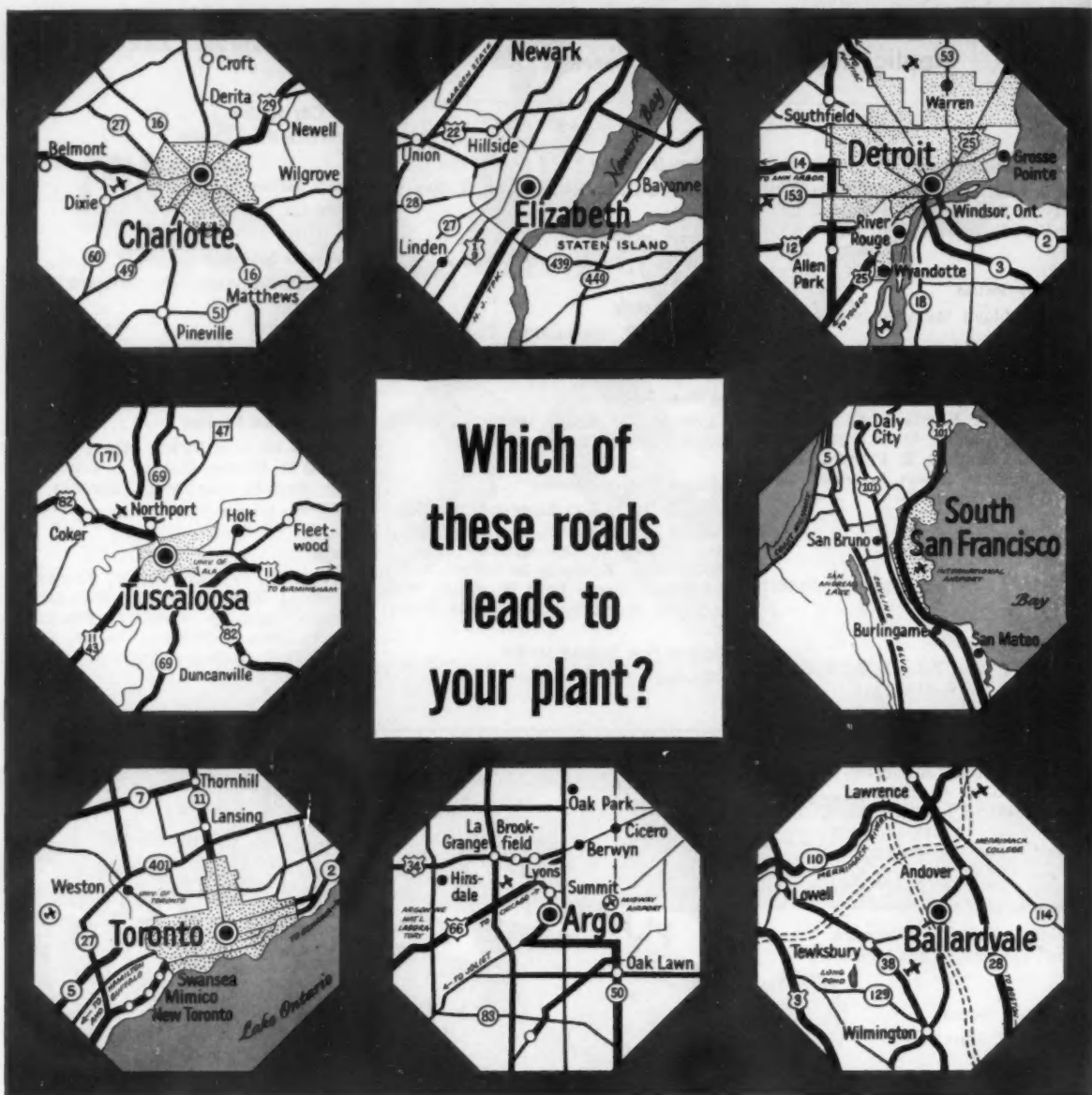
PLASTIC? STAMPED? DIE CAST?

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Play safe. Get an **UNBIASED** recommendation—**AT NO COST TO YOU—from Ainsworth-Precision**

A-P's complete facilities for die-casting, stamping, precision parts machining, metal forming, welding, plastic molding, and assembly eliminate multiple profits and overhead charges. It centralizes responsibility in ONE place. Furthermore, A-P has **SEVEN PLANTS** to serve you—strategically located in Michigan, Ohio, New York, Tennessee, and Illinois—to speed delivery and cut your shipping costs. Send part print for quote, or write for facilities brochure.

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FOUNDRY PRODUCTS
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Education in High Gear

Knowledge is the destination of this vehicle—the world's first Mobile Laboratory for Automotive Research and Education.

J&L stainless steel is used exclusively for exterior and interior components to help assure long, useful life. Part of that life will be devoted to gaining a better understanding of how stainless steel combats corrosion, provides greater structural strength, reduces weight, improves performance.

This unique Mobile Laboratory was presented to the University of Michigan by The International Nickel Company. It was adapted from a 27-foot General Motors Coach by Ionia Manufacturing Div., The Mitchell-Bentley Corp. Contributing companies include: General Motors Corp.—Styling Staff, Engineering Staff, Proving Grounds, Truck and Coach Div., Harrison Radiator Div., and Frigidaire Div.; United States Rubber Company; Lyon, Inc.; and Friez Instrument Div., Bendix Aviation Corp.

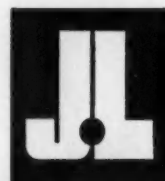


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The high strength and durability of stainless steel can provide greater design freedom, more economical production and longer service life for all functional automotive components.

J&L leads the industry in melt shop standards for stainless steel—the point where quality starts, and engineering achievement begins.

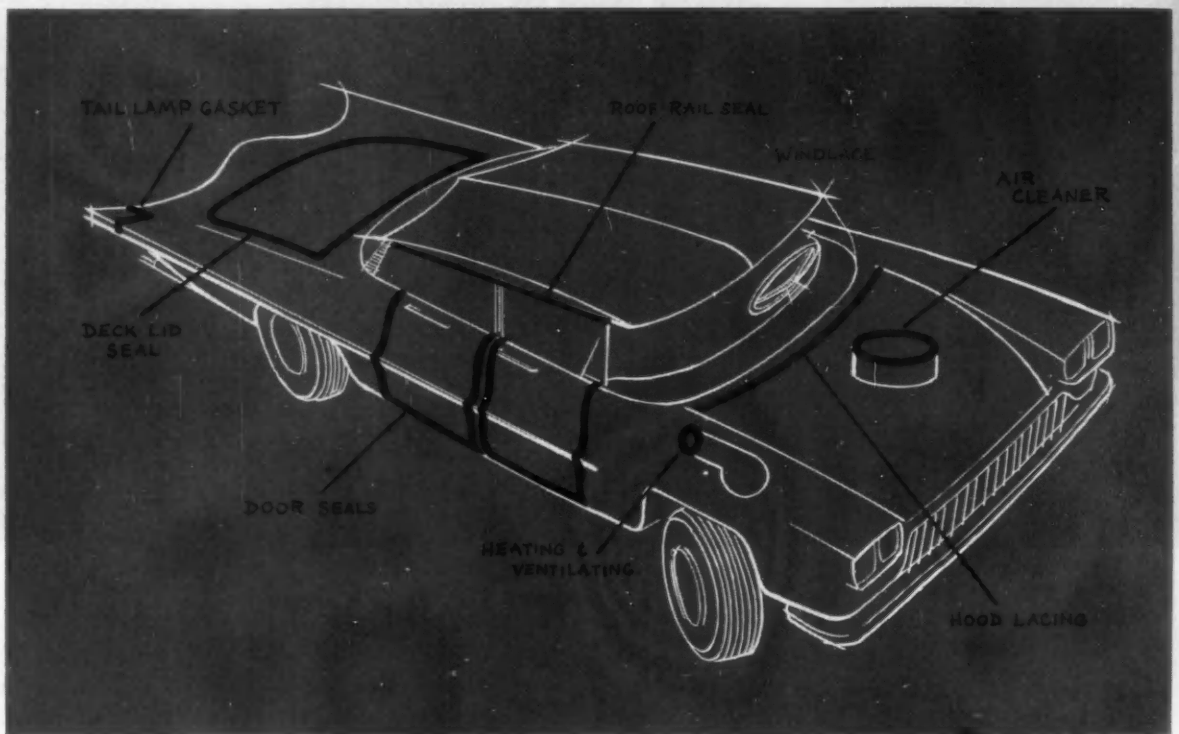


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SHEET • STRIP • BAR • WIRE

Jones & Laughlin Steel Corporation • STAINLESS and STRIP DIVISION • Box 4606, Detroit 34,

A new and improved body seal: extruded closed cell neoprene

New approaches to body sealing and gasketing are possible with extruded closed cell neoprene. It can be extruded into low-pressure body seals of controlled softness that are weather and ozone resistant, and have low water absorption. The "self-skin" of these extrusions and the closed cell structure beneath removes the need for a protective coating. Tighter radii can be turned without wrinkling, providing an effective seal. For more information write for your copy of EXTRUDED CLOSED CELL NEOPRENE SPONGE. E. I. du Pont de Nemours & Co. (Inc.), Elastomer Chemicals Dept. SAE-6, Wilmington 98, Delaware.



Applications of extruded closed cell neoprene.



Complex cross sections can be extruded.



Better Things for Better Living . . . through Chemistry

SYNTHETIC

RUBBER

NEOPRENE
HYPALON®
VITON®
ADIPRENE®

This is all the room you need
to weld with LINDE's
MIGHTY MIDGET*



... New Heliarc
HW-20 Torch



HIGH CURRENT CAPACITY

Operates at 200 amperes *continuous* duty, AC or DC. Molded, totally closed water-cooling system eliminates any chance of leaks at torch head.



MINIATURE SIZE

9/16- by 2-5/16-in. torch head permits welding in hard-to-reach areas as small as 3 in. in diameter. Total torch length is under 7 inches.



3.3-OZ. FEATHERWEIGHT

Selected materials, such as glass fiber reinforced phenolic plastic, save weight without sacrificing strength. Torch (with short cap) weighs only 3.3 ounces.



HANDLES LIKE A PENCIL

Exceptional balance, light weight, small size, and super-flexible service lines make the HW-20 torch as easy to handle as a pencil.

For further information, call your local LINDE Office or LINDE Distributor . . . or write: Dept. SJ-09, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

The terms "Heliarc," "Linde," and "Union Carbide" are registered trade marks of Union Carbide Corporation.

SPECIFICATIONS

Capacity—
200 amp. AC or DC, continuous duty cycle;
225 amp. AC or DC, reduced duty cycle

Weight—
with short cap: 3.3 oz.*
with medium cap: 3.5 oz.
with long cap: 3.6 oz.

Length overall—6 7/8 in.

Length of Torch Head—
with short cap: 2-19/64 in.*
with medium cap: 3-9/32 in.
with long cap: 7-5/16 in.

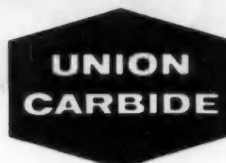
Maximum Handle Diameter—3/4 in.

Maximum Head Diameter—9/16 in.

Service Lines—12 1/2 or 25 ft.

*Torch is supplied with medium cap for 3-in. electrodes. Short cap for 2-in. electrodes and long cap for 7-in. electrodes are available as accessories.

Linde



*Koenig rolls up 77,152 trouble-free miles
with a Spicer 5-speed transmission during FORD'S*

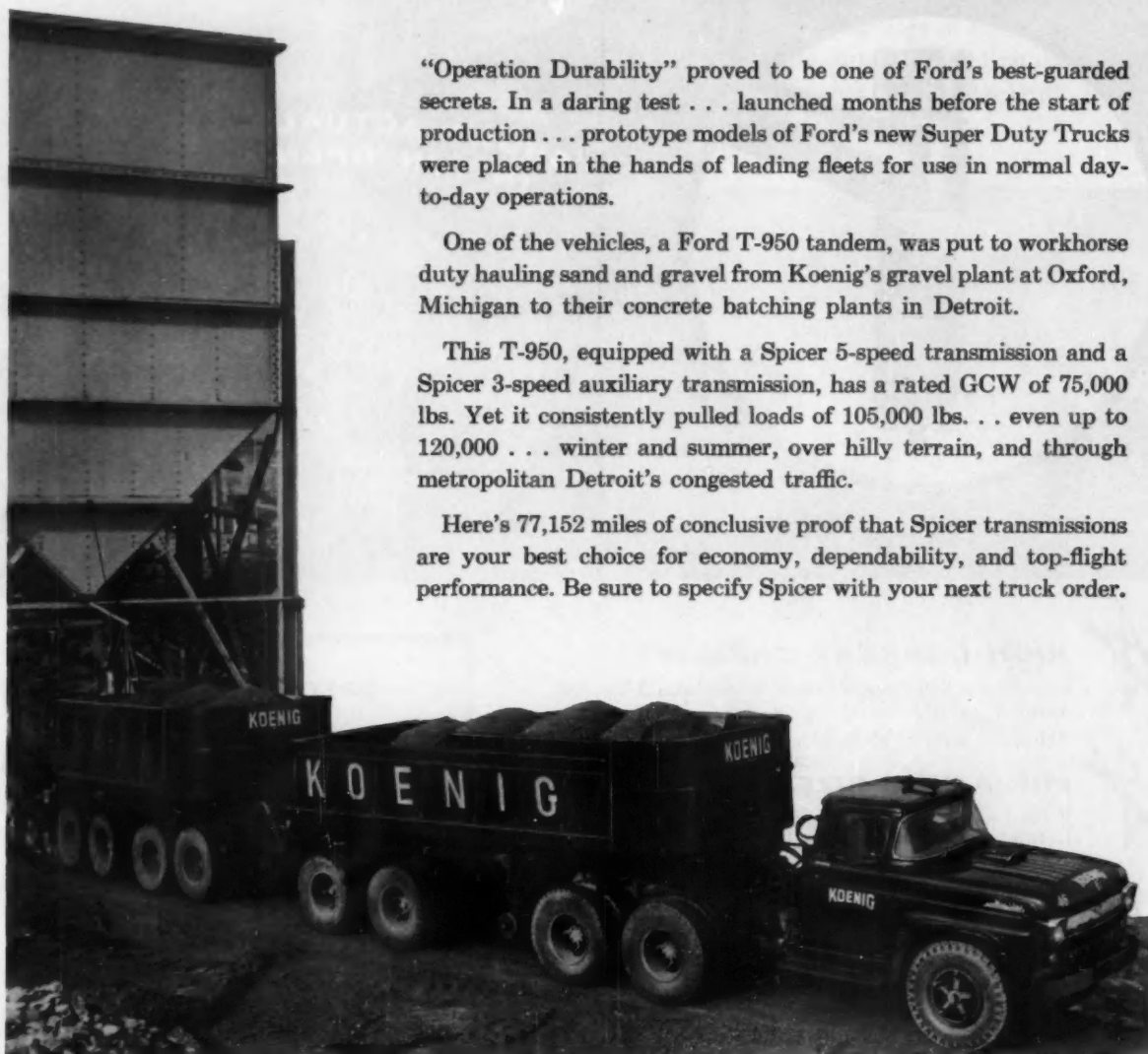
"OPERATION DURABILITY"

"Operation Durability" proved to be one of Ford's best-guarded secrets. In a daring test . . . launched months before the start of production . . . prototype models of Ford's new Super Duty Trucks were placed in the hands of leading fleets for use in normal day-to-day operations.

One of the vehicles, a Ford T-950 tandem, was put to workhorse duty hauling sand and gravel from Koenig's gravel plant at Oxford, Michigan to their concrete batching plants in Detroit.

This T-950, equipped with a Spicer 5-speed transmission and a Spicer 3-speed auxiliary transmission, has a rated GCW of 75,000 lbs. Yet it consistently pulled loads of 105,000 lbs. . . even up to 120,000 . . . winter and summer, over hilly terrain, and through metropolitan Detroit's congested traffic.

Here's 77,152 miles of conclusive proof that Spicer transmissions are your best choice for economy, dependability, and top-flight performance. Be sure to specify Spicer with your next truck order.



DANA

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SERVING TRANSPORTATION — Transmissions
Auxiliaries • Universal Joints • Clutches • Propeller
Shafts • Power Take-Offs • Torque Converters
Powr-Lok Differentials • Gear Boxes • Forgings
Axles • Stampings • Frames • Railway Drives

Many of these products are manufactured in Canada by Hayes Steel Products Limited, Merriton, Ontario

style is stainless steel

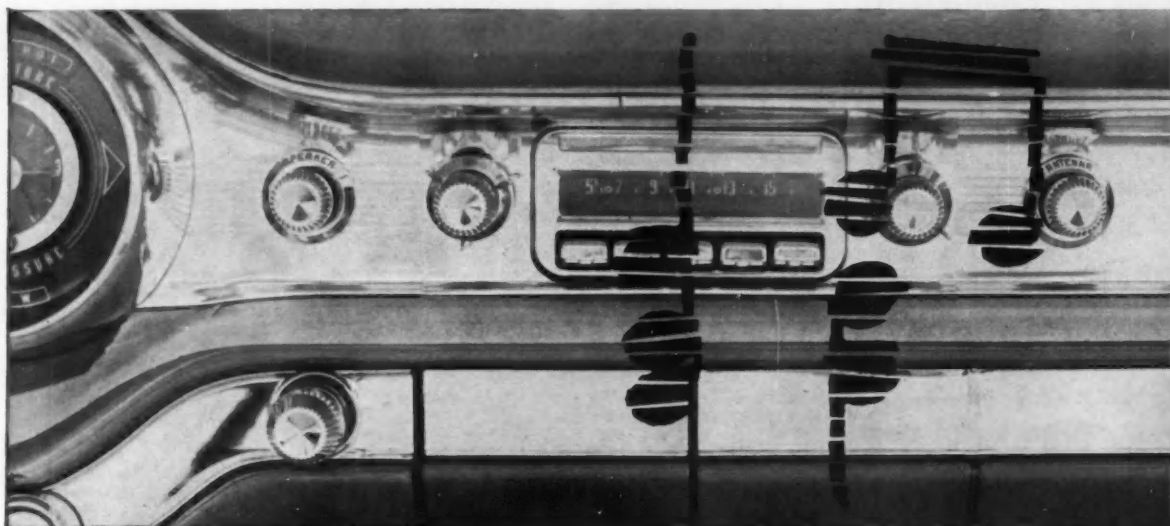
Stainless Steel is the only surfacing material with a hard lustrous finish that is always in style, withstands exposure to all kinds of wear and has a low maintenance cost for the life of the building.

No other metal offers the freedom of design and fabrication, economy of care and the durable beauty that serves and sells like Stainless Steel.

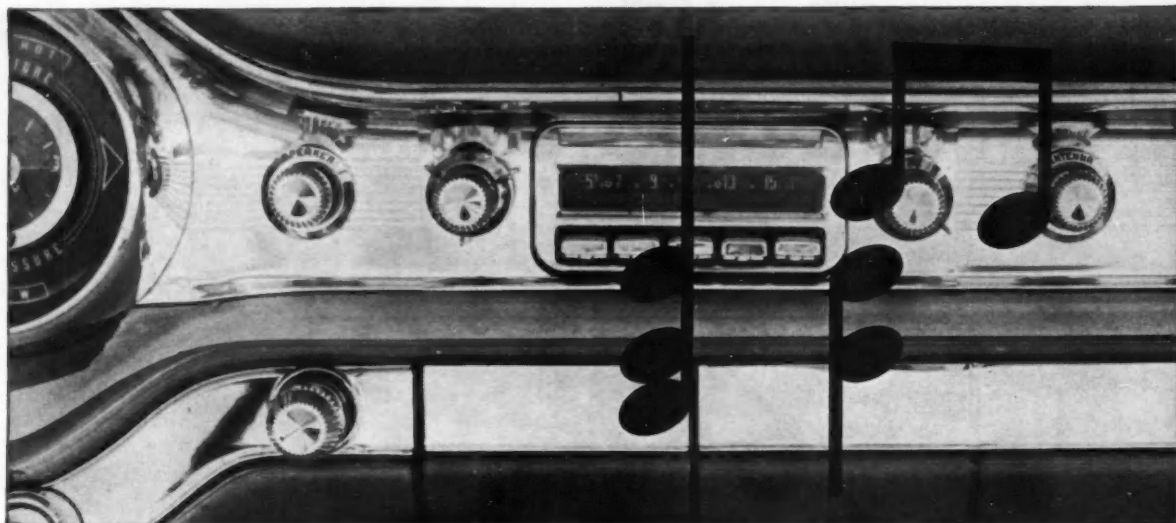
McLOUTH STEEL CORPORATION, Detroit 17, Michigan



specify
McLOUTH STAINLESS STEEL
HIGH QUALITY SHEET AND STRIP
for architecture



INTERFERENCE / *caused by ordinary cable*



ELIMINATED / *with Packard T.V.R.S. cable!*

The annoying interference with radio receivers, created by automotive ignition systems, was a real problem. Old attempts to handle it included resistors at the distributor and spark plugs, but they were only a partial answer. Packard Electric engineers developed a special non-metallic conductor designed to distribute suppression evenly throughout the cable. Same sturdy rubber-neoprene insulation, same long life as other Packard cable, but with better reception for car radios, nearby radio and television sets and 2-way mobile communications sys-

tems. In spite of the benefits enjoyed through the use of T.V.R.S. Ignition Cable, there is no sacrifice of engine performance!

Now, Packard's exclusive T.V.R.S. (Television-Radio-Suppressor) cable is standard equipment on most new cars. The specialized knowledge of Packard engineers who solved that sore problem is at your service to help you design other cost-cutting or service-improving items. Packard Electric maintains offices in Detroit, Chicago, and Oakland, California for your convenience.

Packard Electric
Warren, Ohio



"Live Wire" division of General Motors

Titeflex, Inc., Meets Aircraft Fuel, Lubrication and Hydraulic Line Specifications with **HANDY & HARMAN BRAZE 541**



Titeflex operator brazes assembly with torch and hand-fed Handy & Harman Alloy BRAZE 541. Titeflex is unique in that it makes flexible hose assemblies from raw material to end product—"From End to End, Inside and Out, made RIGHT In Our Own Plant."

This Springfield, Massachusetts, manufacturer of aircraft and missile fuel, lubrication and hydraulic lines finds that silver alloy brazing with Handy & Harman BRAZE 541 meets rigid operating requirements "all the way down the line."

The tubing and fittings of many of the wide range of assemblies made by Titeflex are 321, 316 and 347 stainless steel and Monel. Brazing is a hand torch, wire and HANDY FLUX operation.

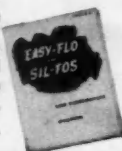
BRAZE 541 is a plastic alloy which melts at 1325° F and flows at 1575° F. Its strength—in shear—at elevated temperatures is 21,500 psi at 500° F and 15,000 psi at 750° F. This alloy's ductility in resisting stress and vibration is very high and its resistance to oxidation

and corrosion is equally impressive. The composition of BRAZE 541 is 54% silver, 40% copper, 5% zinc and 1% nickel. It meets AMS Specification 4772.

Aircraft and missile component manufacturers and fabricators are finding—to their and their products' benefit—that Handy & Harman silver alloy brazing is the full and *final* solution to their metal-joining problems. BRAZE 541 is but one of a large family of Handy & Harman alloys, for both low and high temperature applications. We would like to more fully acquaint you with BRAZE 541 and with the advantages that come naturally to silver brazing as a metal-joining (both ferrous and nonferrous) method. Handy & Harman, 82 Fulton Street, New York 38, N. Y.

FOR A GOOD START: BULLETIN 20

This informative booklet gives a good picture of silver brazing and its benefits... includes details on alloys, heating methods, joint design and production techniques. Write for your copy.



Your No. 1 Source of Supply and Authority on Brazing Alloys

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General Offices: 82 Fulton St., New York 38, N. Y.

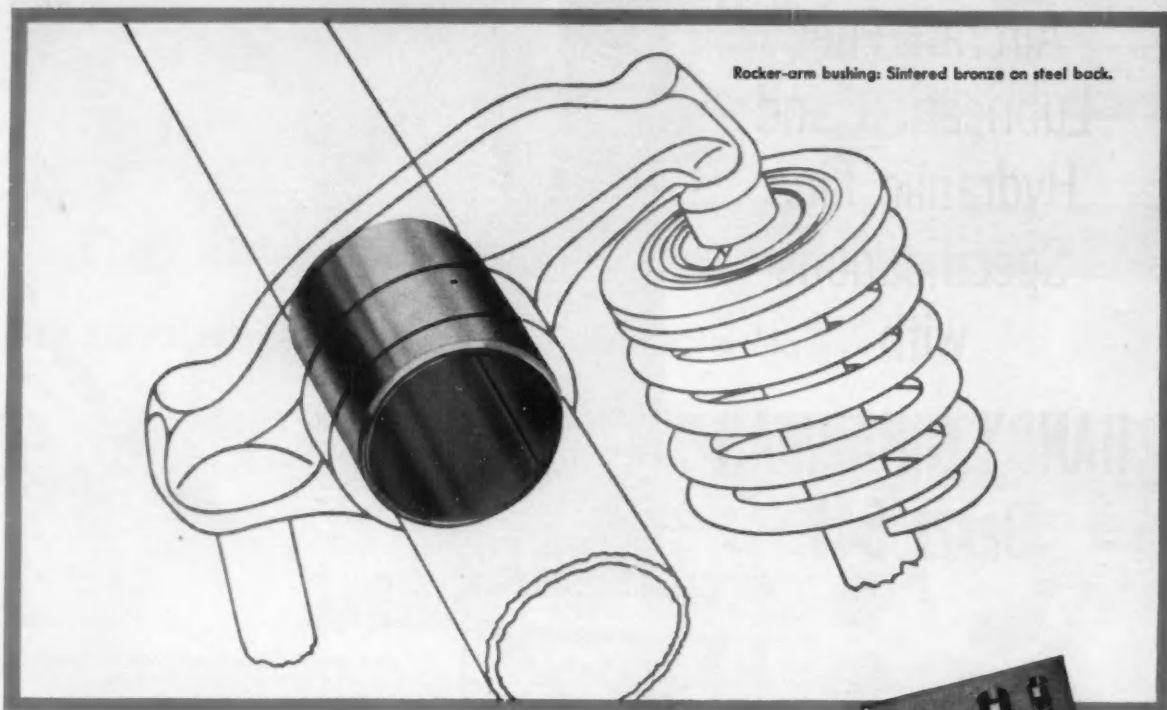
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Carrying the rocker-arm load . . .

FORMED BUSHINGS

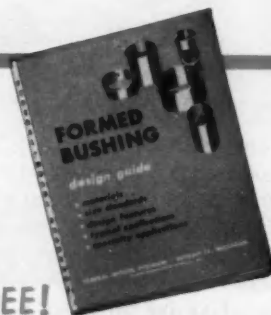
SAVE SPACE—SAVE WEIGHT—SAVE COST!



Here's a typical application in which the design engineer uses formed bushings to meet both performance and cost demands.

This rocker-arm bushing is formed from sintered bronze-on-steel strip. In fast oscillation, at 200 p.s.i. average loading, it has an average life of 5,000 hours, or 150,000 miles. Cost-wise, you will find it attractive. Space and weight are saved, with no sacrifice of strength or service life.

There are countless other applications in motor, machine and accessory design, where formed bushings deliver equal satisfaction. Let our engineers assist you. Consultation is free—no obligation.



FREE!

Bushing Design Guide, technical publication by our Engineering Department. Shows materials, size standards, design and application features. Write today!

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11035 SHOEMAKER, DETROIT 13, MICHIGAN



Copper-Alloy
Lined
Bearings



Spacer
Tubes



Camshaft
Bearings



Precision
Thrust
Washers





HOW THE SILICONES MAN HELPED...

MAKE THE TAPE THAT FORMS A PERFECT SKIN

Wrap a fully cured tape of this new silicone rubber around a cable . . . in a short time it fuses into a homogeneous mass! Press a molded or extruded piece of this rubber into position and it will stay firmly in place. From research at UNION CARBIDE, the Silicones Man brings you the world's first *fusible*, silicone rubber.

This new product has all the properties usually associated with premium silicone rubber . . . outstanding high temperature performance, good electrical and oil resistance, excellent reversion resistance among them. You can well imagine the many applications in electronics gear, high temperature

locations . . . how assembly work will be speeded by "press-in-place" construction. Here is another example of how the specialized knowledge of the Silicones Man has helped solve an "impossible" problem.

Write for data on "Fusible Silicone Rubber" or any of the many other silicones products available through the Silicones Man. Address Box EA-9706, Silicones Division, Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. (In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Toronto 7, Ontario)

Unlocking the secrets of silicones

Rubber, Monomers, Resins, Oils and Emulsions

The term "Union Carbide" is a registered trade-mark of UCC.



SILICONES



One of the earliest and most basic breakthroughs in fastener design was the common safety pin. And, although DOT is not a manufacturer of safety pins, many a DOT industrial fastener has had an equally revolutionary effect on modern fastening technique. Hundreds of different DOT fasteners have created relatively minor revolutions in specific industries.

A DOT fastener may save a few man-minutes of labor. It may save material. Or it may improve product performance and hence saleability. But multiply each small improvement by the number of units in a true mass-production operation and the savings really pile up to impressive proportions.

Rather than spend your own design staff's time on fastening problems, it might pay you well to call in DOT. You'll have at your service a design and production organization with large-scale facilities for genuine mass-production of special-purpose fasteners and self-fastening devices of all kinds.

Supplementing the Carr Fastener Company are a number of other plants which form the United-Carr Fastener group. They are located in the principal production centers of the United States, Canada, England and Australia. Your nearest United-Carr Field office (see below) is no further away than a telephone call from your desk.



CARR FASTENER COMPANY

Cambridge 42, Massachusetts

Offices In:

Atlanta, Boston, Chicago, Cleveland, Dallas, Detroit, Los Angeles, New York, Philadelphia, Syracuse

DELCO RADIO

NEW POWER TRANSISTORS



MILITARY-COMMERCIAL

	2N1168	2N392	2N1011	2N1159	2N1160
V_{ce} max.	50	60	80	80	80 volts
I_c max.	5	5	5	5	7 amp.
I_{ce} (V_{ce} 2 volts) Typical 25°C.	65	65	65	65	65 μa.
HFE (3 amp.)	—	60-150	30-75	30-75	—
HFE (5 amp.)	—	—	—	—	20-50
AC Power Gain ($I_c = 0.6$ amp.)	37 DB	—	—	—	—
V_{ceo} ($I_c = 1$ amp.)	40 typical	50 typical	60 min.	60 min.	60 volts min.
Thermal Gradient max.	1.5	1.5	1.2	1.2	1.2° c/w

Delco Radio rounds out its power transistor line with this new 5-ampere germanium PNP series. Types 2N1168 and 2N392 are specially designed for low-distortion linear applications, while 2N1159 and 2N1160 are outstanding in reliable switching mode operations.

Type 2N1011 is designed to meet MIL-T-19500/67 (Sig. C). It joins 2N665, MIL-T-19500/68 (Sig. C); 2N297A, MIL-T-19500/36 (Sig. C) and JAN2N174, MIL-T-19500/-13A to provide a selection for military uses.

Write today for engineering data on Delco Radio's line of High Power Transistors.

See you at the WESCON Show, Booth No. 114

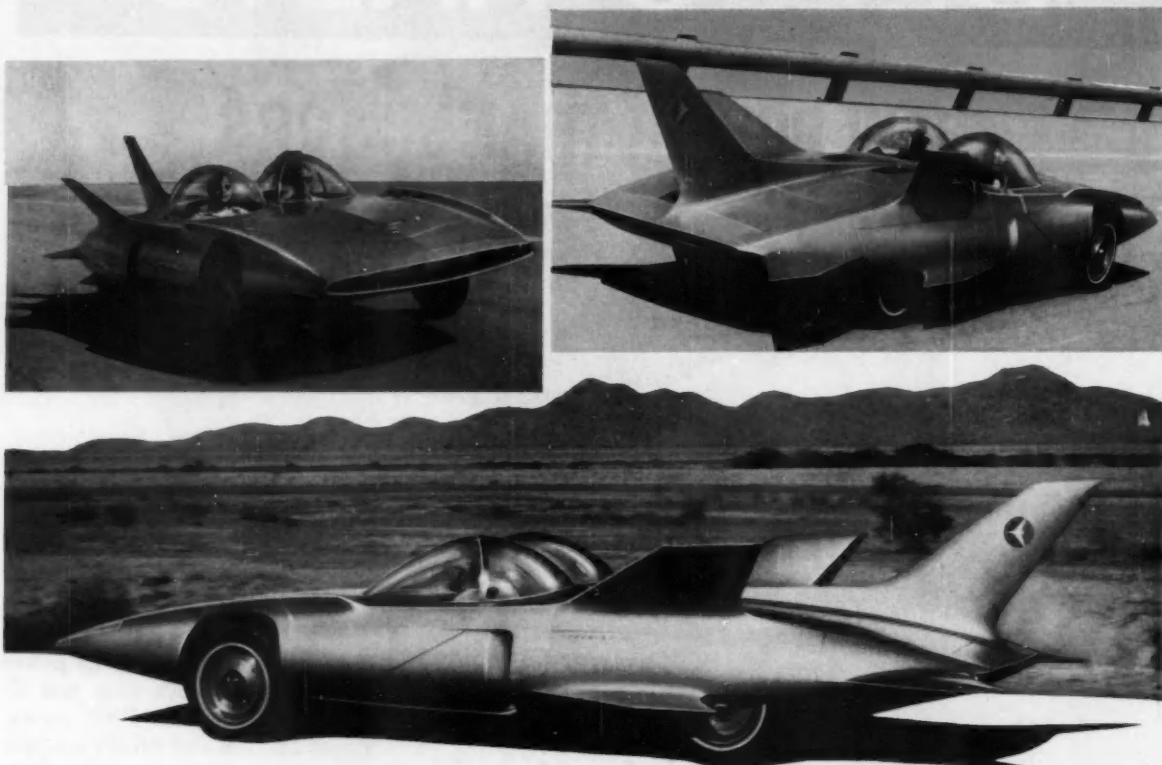
DELCO
DEPENDABILITY
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RELIABILITY

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NEW AUTOMATIC CLIMATE CONTROL BY HARRISON *for FIREBIRD III*



GENERAL MOTORS USHERS IN A NEW CONCEPT IN CAR AIR CONDITIONING!

From Harrison's extensive research facilities comes the latest advance in future passenger comfort. It's the *first fully automatic climate control for cars!* And it's ready to go on Firebird III, General Motors' daring new, experimental dream car. Passengers can travel from the Arctic to the Equator and keep inside car temperature constant with a single setting of just one small dial. This is the most advanced heating and cooling system yet devised for cars. And of course it comes from Harrison . . . for no one is better equipped to design air conditioning for the cars of tomorrow than the leader in heating and cooling the cars of *today!* Harrison's engineering and manufacturing skill has solved temperature control problems in every line of industry and defense. If you have a heating or cooling problem, look to Harrison for the answer.



HARRISON RADIATOR DIVISION OF GENERAL MOTORS, LOCKPORT, NEW YORK



*Gyroscopic Suspension
by Mather about 900 B.C.*

**LET
MATHER
SOLVE
YOUR
SUSPENSION
PROBLEMS,
TOO**

It doesn't take a Gyroscopic expert to detect a few flaws in this smooth ridin' rig of Ulysses, nor is anyone likely to believe that Mather rigged it as this headline infers.

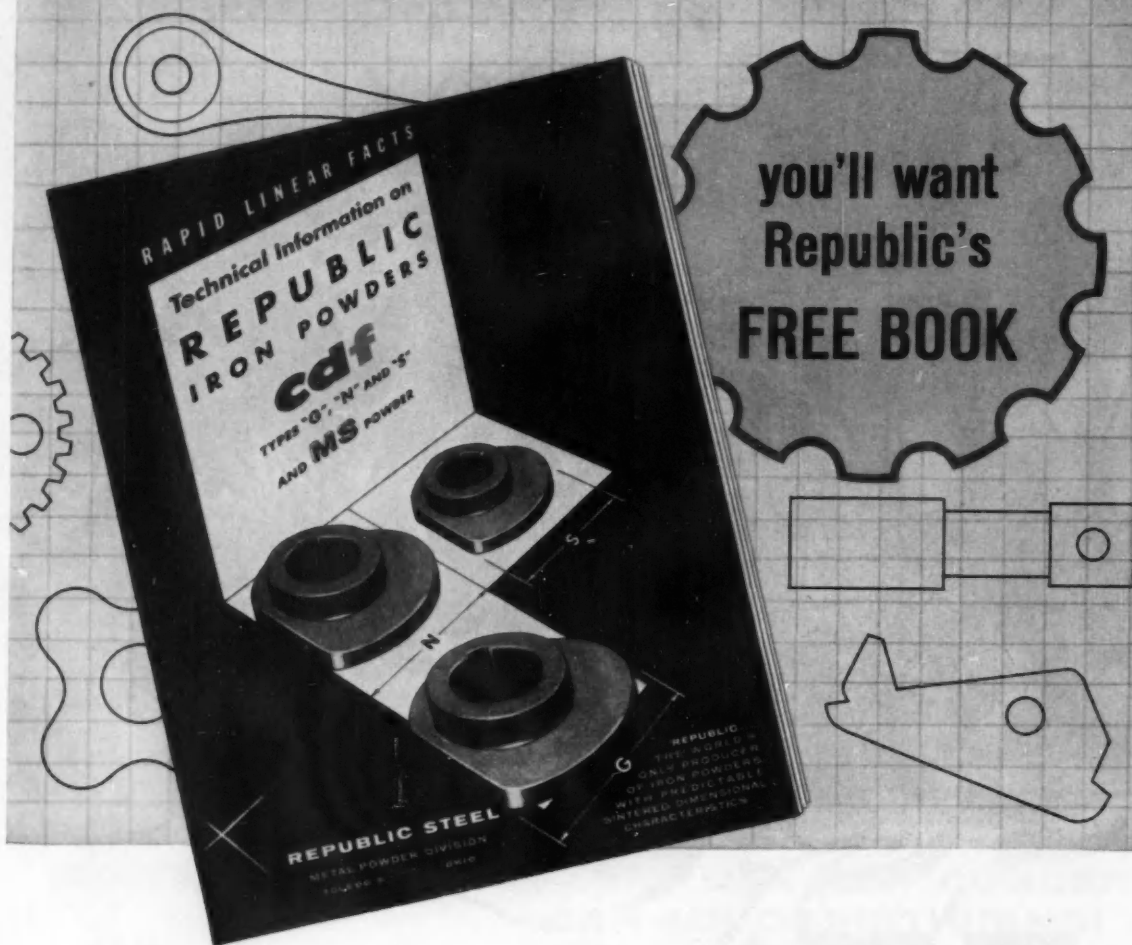
We do want you to know, though, that we've had fifty years of suspension experience and that our research design and manufacturing facilities are available to you. Just call CH 3-3201, or write, and a Mather representative will see you at your convenience.

MATHER

THE MATHER SPRING COMPANY
TOLEDO, OHIO



If you design or fabricate iron powder parts...



This new 48-page book has been prepared especially for tool engineers, part designers, metallurgists, and fabricators. It contains complete technical data on Republic's improved Controlled Dimensional Factor Powders and new MS Powder.

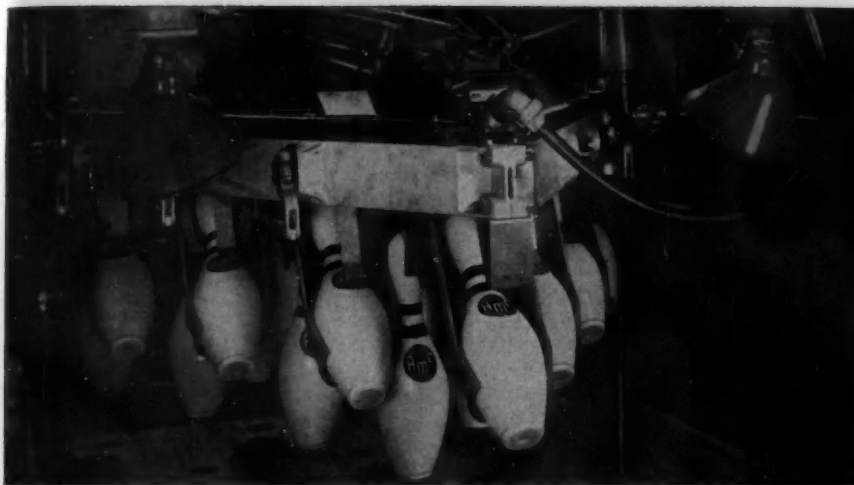
Data are presented by an entirely new method. Most of the necessary information regarding a particular powder's behavior can be read from the curves on a single set of ordinates.

The first section of the book lists complete specifications for Republic's CDF Powders, Type "G" for growth, Type "N" for normal, Type "S" for

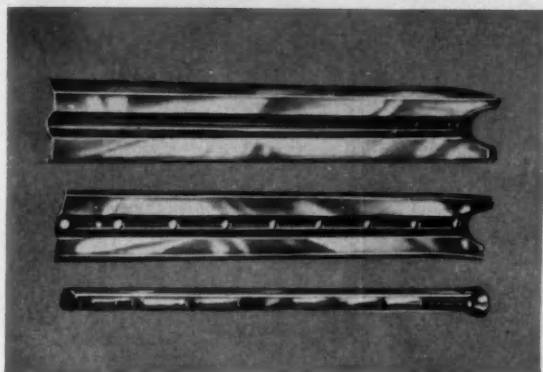
shrinkage. Each of these powders has been improved with regard to compressibility, dimensional characteristics, and increased tensile strengths.

Section two provides complete information on Republic's new MS Powder, developed principally for use with graphite rather than copper. MS possesses features which make it economically attractive for use in a wide variety of mechanical parts, and in electrical and magnetic applications.

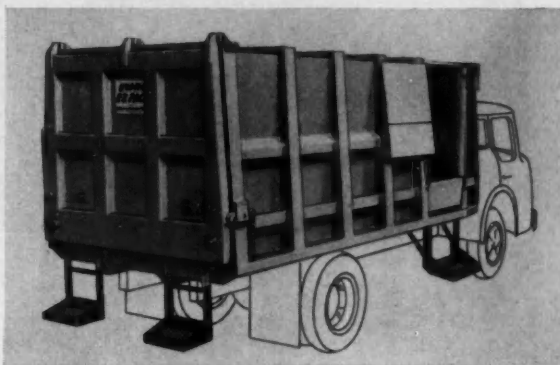
Mail the coupon for your free copy of Republic's new Iron Powder Book, ADV. 1014.



AMF CUTS COSTS, builds a better pinspotter with Republic ELECTRUNITE® Mechanical Tubing. On the initial order, ELECTRUNITE saved American Machine & Foundry Company, Brooklyn, New York, \$34,000 in manufacturing their famous AMF Automatic Pinspotter. AMF was able to eliminate boring and grinding operations because ELECTRUNITE met O. D. tolerance requirements. This feature resulted in a savings of \$15,000 in fabricating operations. Another \$19,000 was saved on the cost of ELECTRUNITE as compared with tubing previously used. In uniformity, quality, original costs, Republic ELECTRUNITE Mechanical Tubing can save you time and money, too. Call Republic, or mail coupon for facts.



GREATER STRENGTH, CORROSION-RESISTANCE, and cost were prime factors in switching to stainless steel from brass in this automotive engine water distribution tube. Stainless was easily fabricated on existing tools. It took the constant flow of hot water and anti-freeze chemicals in stride. The greater strength of stainless virtually eliminated loss from bent or damaged tubes. Photo sequence shows fabricating operations: (1) Blank of .010" stainless strip after initial drawing and embossing, (2) Same blank after piercing of water outlet holes and trimming of flanges, (3) Completed tube after roll-forming and lock seaming. Mail coupon for more information on Republic ENDURO® Stainless Steel.



HIGH STRENGTH STEEL SOLVES WEIGHT PROBLEM in Hydro E-Z Pack enclosed truck bodies, manufactured by Hercules Galion Products, Inc., Galion, Ohio, for haulers of refuse and garbage. Tough, strong, lightweight Republic "50" High Strength Steel allows an E-Z Pack unit to be carried on a chassis as small as a two-ton truck. Reduced weight permits increased payload—fewer trips to the dump. High Strength Steel withstands the heavy compressive force of packer blades, allows tight compaction of loaded materials. High resistance to the corrosive and abrasive action of refuse assures long, dependable service. Write for full facts on Republic High Strength Steel.

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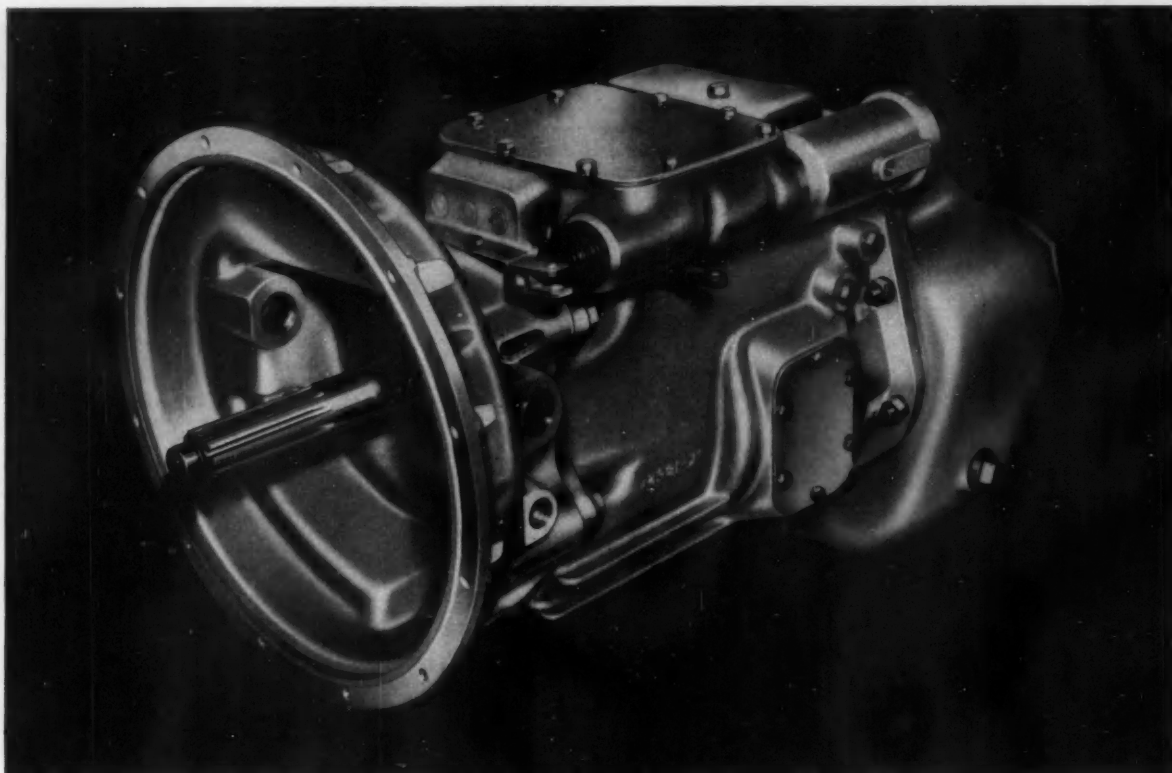
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This is the experience background of Clark's new, lightweight 9-speed transmission... a background which gives you:

- **Light weight.** Transmission, complete, weighs only 515 lbs. All aluminum housings.
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- **9 speeds with ratios matched to the demands of modern**

diesel hauling. Low-gear ratio, 9.35 to 1, starts heavy loads easily.

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- **Low silhouette,** provides clearance under cab or trailer.
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MORE PROOF OF MORE TIRE POWER

In 16 million miles of New York City taxi driving, tires with TYREX viscose cord had 26% less failures than nylon.

Tested on New York City taxi fleets, tires with TYREX viscose cord took the beating of big city driving 24 hours a day, 7 days a week. So did nylon—but not for long.

ROUGH TIME FOR TREADS

In the stop-and-go driving of New York City traffic, excessive braking nearly skinned these tires alive. So did jet take-offs and squealing turns. Still and all, tires with TYREX viscose cord proved considerably more durable in the long run than those made with nylon.

REPEATED IMPACTS PART OF DAILY GRIND

In this round-the-clock torture test, tires took plenty of brutal abuse from curbs, pot holes, railroad crossings, streets under repair. Here too, tires with TYREX viscose cord showed greater strength with 26% less failures than nylon per million tire miles.

GROWTH GETS THE ACID TEST

Every tire was under fire in this grueling marathon of taxi driving. Temperatures and pressures built to a peak. But tires with TYREX viscose cord proved superior here too, with substantially less growth than nylon—and no morning thump!

IMPORTANT NOTE ABOUT TEST CONDITIONS: *All tires used in this test were of identical construction and equal carcass strength—the only difference being in the tire cord used.*

TYREX INC., EMPIRE STATE BLDG., NEW YORK 1, N. Y. *TYREX is a certification mark of Tyrex Inc., for viscose tire cord and yarn. TYREX viscose tire cord and yarn is also produced and available in Canada.

Modern carburetors need the protection of new **PUROLATOR FUEL FILTERS**



Particles of dirt only 10 microns in size are large enough to cause flooding or stalling in modern carburetors. Effective *positive* filtration is essential for delivering the clean fuel modern four-barreled carburetors must have for efficient operation.

Purolator's new Micronic® fuel filters are designed specifically for the requirements of modern carburation. They are compact, light-weight units with a positive type Micronic element sealed in a Terneplate steel housing.

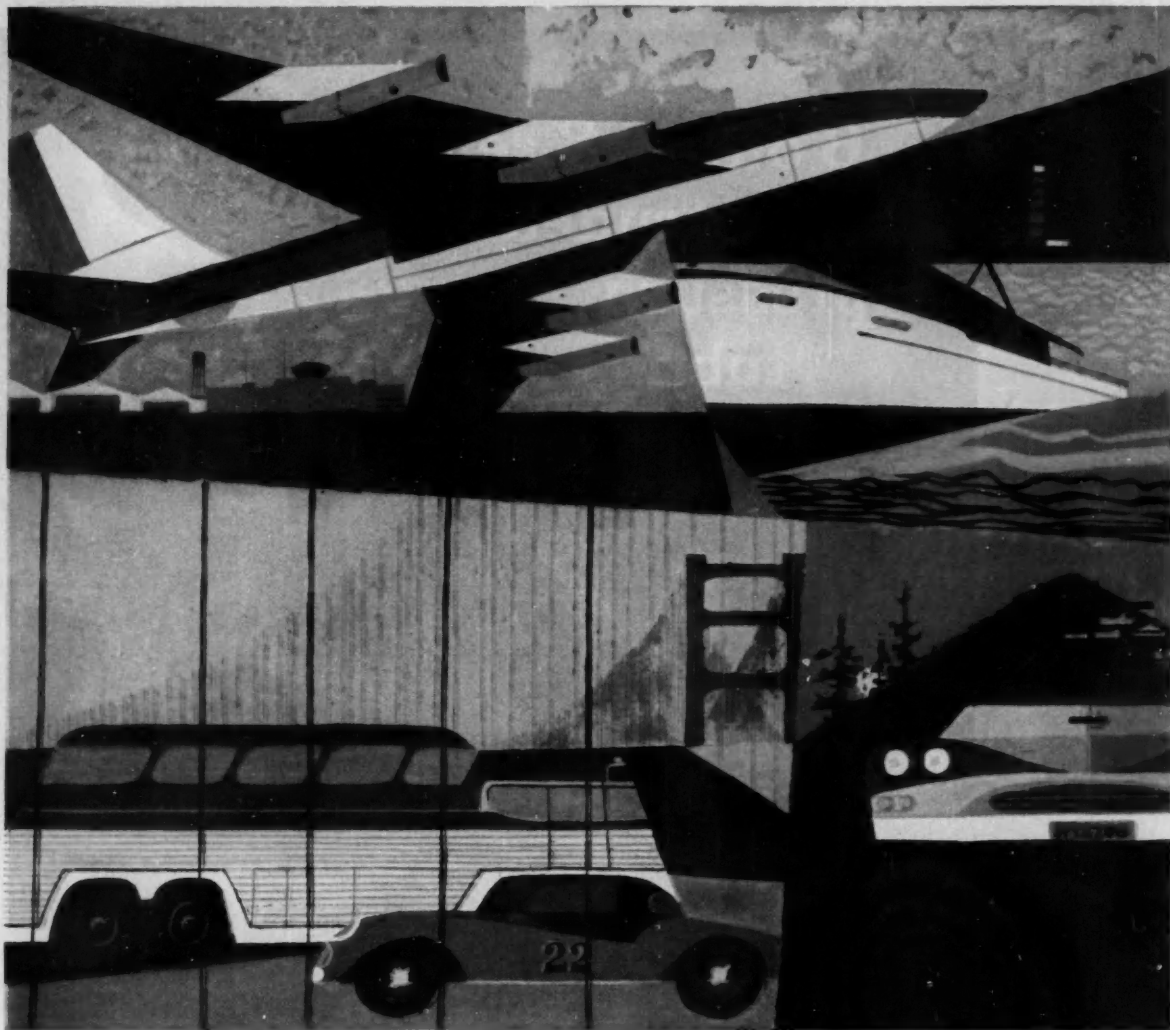
The little unit shown measures only 2 $\frac{3}{8}$ " x 1 $\frac{1}{2}$ "—but packs 52 square inches of filtering area into a housing capacity of 4.5 cubic inches. The low-cost, easily replaceable unit gives completely effective filtration—and long life.

The Model GF-11 is already in use as original equipment on many engines. It is easily incorporated into any fuel line. For full specifications on the GF-11 and other Purolator fuel filters, write to Purolator.

*Filtration
For Every Known
Fluid*

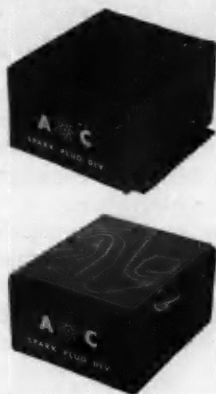
PUROLATOR
PRODUCTS, INC.

RAHWAY, NEW JERSEY AND TORONTO, ONTARIO, CANADA



ELECTRONICS PROBLEM? SEE AC!

Get the facts on this new transistorized inverter



New AC Transistorized Inverter, exterior-interior views.

AC is a leader in solving electronics problems—and in the forward planning of electronics equipment to solve anticipated problems.

AC's new Transistorized Inverter offers a prime example of AC's electronic leadership. This newly developed device converts low voltage direct current to high voltage alternating current for the operation of fluorescent lights and small motors in buses, airplanes, cars and boats.

Its big advantage is in transistor action which accomplishes current conversion without need for any rotary or vibratory moving parts.

This means lower installation cost—as much as 50% less than conventional mechanical types.

And it means far lower operational cost—with longer life and greater reliability—since no lubrication, maintenance or replacement parts are required.

The 125-watt unit, recommended for most installations, is approximately 3" x 5" x 5", weighs only 2½ pounds and is designed to operate throughout an ambient temperature range of -40°F to +160°F with high efficiency. It is self-protecting in event of shorted load.

Do you have a battery-powered alternating current problem? Let us help you with complete information on the AC Transistorized Inverter and other advanced AC Engineering ideas.

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THE ELECTRONICS DIVISION OF GENERAL MOTORS



Six out of eight contracts recently awarded for new power plants specified Curtiss-Wright extruded pressure tubing for steam and reheat lines.

Utility, engineering firm and fabricator select CURMET tubing because its longer length reduces welds—because the metal itself is improved by the exclusive extrusion method. For example, keeping metal under 24,000,000 pounds compression forces flow in both axial and radial directions so that transverse and longitudinal strength are nearly the same.

The foresightedness of public utility management leads

to the specification of materials that will stand up under ever-increasing operating temperatures and pressures. And equally as visionary are the engineering firms and fabricators who assist in the design and construction of these power plants for the decades to come.

CURMET tubing, from 8" to 20" OD, is available in premium grade carbon steels—chrome-moly, stainless and similar quality alloys.

Write for more complete information on this CURMET process—the superior properties—and the premium quality that it gives to metals.

CURTISS-WRIGHT
CORPORATION 77 GRIDER STREET



METALS PROCESSING
DIVISION
BUFFALO 15, NEW YORK

Ross variable-ratio steering has



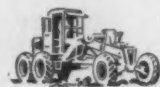
been proved in service by 31 of



today's vehicle manufacturers...



including 9 of 13 makers



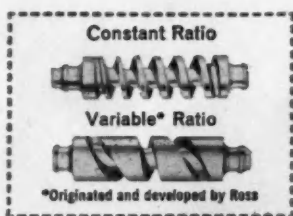
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STEERING

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Tough jobs call for the right equipment . . .

EVANS HEATERS

are right for trucks because
they are built for trucks!

A passenger car heater is fine for an automobile, but it's as out of place in a commercial vehicle as a convertible would be in the scene below. To heat your truck *properly*, a *truck-built* heater is a must!

Whatever your truck heating requirements—whether for a conventional truck or an extra-heavy-duty giant—there's an Evans heater custom-tailored to your needs. Evans heaters are designed to provide both the correct BTU output *and proper heat distribution* for the truck in which they are installed. What's more, they give you the rugged dependability and durability you need . . . the high truck-heating performance you want.

If you have a particular truck heating problem, an Evans heating engineer will be glad to call and help you work it out. For complete information, write Evans Products Company, Dept. 4-9, Plymouth, Michigan.

Proved in the field, Evans truck-built heaters offer the utmost in heating comfort and efficiency—even when temperatures drop below zero for extended periods.



Regional Representatives: Cleveland, Frank A. Chase • Chicago, R. A. Lennox
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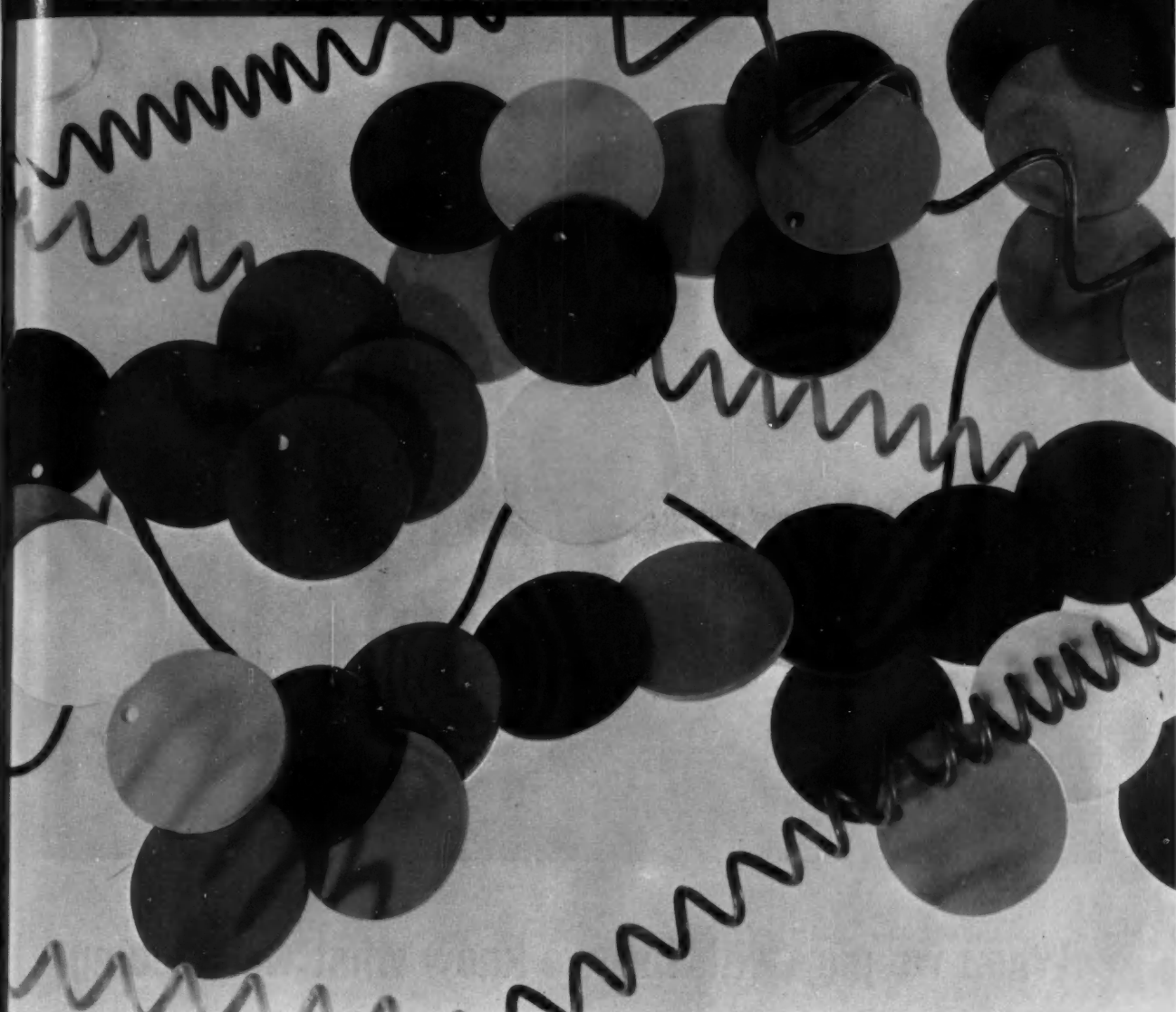
**EVANS TRUCK AND BUS HEATERS
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EVANS PRODUCTS COMPANY • PLYMOUTH, MICHIGAN

Naugatuck PARACRIL OZO

THE OIL-RESISTANT, OZONE-RESISTANT NITRILE RUBBER



Need color in a weather-resistant rubber product?

PARACRIL® OZO will give you all the color you want...any color...permanent, gleaming color for every kind of rubber product, from electric wire to oil pump hose to shoe soles.

Now you can give your product powerful extra selling features...color that attracts, that warns, that identifies, that helps emphasize or hide.

Along with color, PARACRIL OZO gives you a combina-

tion of weather resistance, abrasion resistance, oil resistance, flex life and other valuable rubber properties far surpassing conventional weather-resistant rubbers.

See if your product doesn't call for PARACRIL OZO. To find out more about this proven new rubber and the properties it offers your product, contact your Naugatuck Representative or write us today.

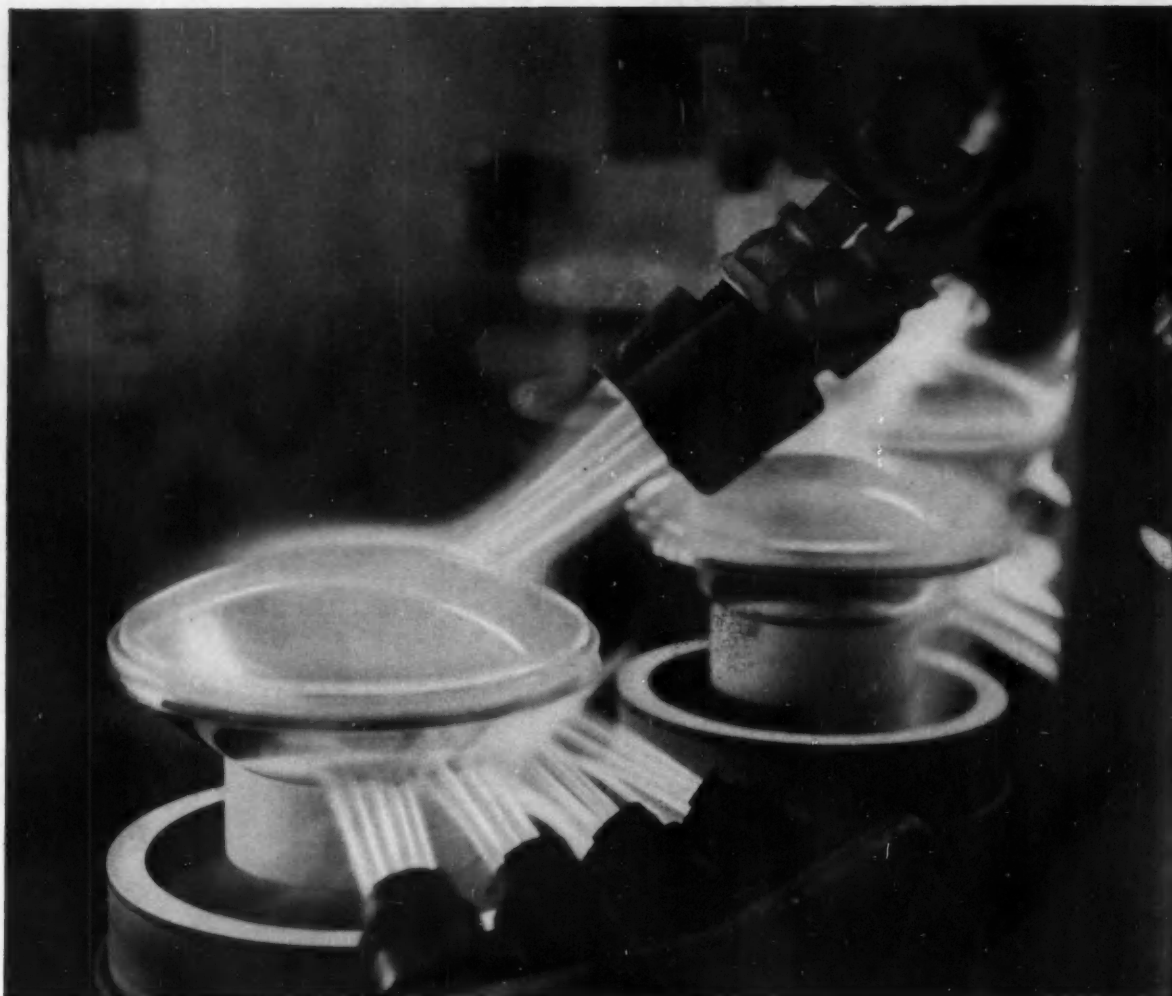


Naugatuck Chemical

Division of United States Rubber Company

928P Elm Street
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When we play with fire we know what we're doing

This is one of the uses of fire that Tung-Sol knows best—the sealing operation that joins the lens of a sealed beam headlamp to the reflector. It is one of the most critical of all operations in the manufacture of automobile headlamps. Intense jets of propane flame must be precisely controlled to bring the glass to a plastic stage at the flanges without disturbing the configuration of either part. Tung-Sol's ability to use fire constructively is just one of the many skills acquired in half-a-century of lamp-making.

In addition to pioneering the development of automotive lamps, Tung-Sol designed and developed the universally used Tung-Sol signal flasher. Tung-Sol circuit breakers protect the electrical equipment circuits in today's automobiles.

The Tung-Sol lamp line includes a wide selection of types developed for instrument panels and similar low voltage equipment applications. Consult Tung-Sol about your lamp requirements. Tung-Sol Electric Inc., Newark 4, New Jersey. TWX: NK 193



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Sealed Beam and Miniature Lamps—Flashers—Circuit Breakers

give the gentleman what he wants...

Yes... that
means piston ring
PRECISION, too!

Precision is one of the ingredients we have uppermost in mind as we daily seek to live up to our service slogan for the Automotive Industry... GIVE THE GENTLEMAN WHAT HE WANTS. We know he wants precision in all things. And the Chef never lived who could slice to the fine tolerances we do in making piston rings for the car factories... truck makers... engine builders. In our temperature conditioned plant at Manchester, Missouri, every known step of precision control is taken... specially-designed machines have been developed... so that the GENTLEMAN WILL GET WHAT HE WANTS in ring parallelism, flatness, finish, tolerance, quality control.

Why not begin a trip through our plant by sending for the booklet, "MOST MODERN RING PLANT." It will introduce you to the results of more than fifty years of serving the great automotive industry... a plant geared to giving THE GENTLEMAN WHAT HE WANTS.



Piston Rings by THOMPSON PRODUCTS RAMCO DIVISION

Another Product of **Thompson Ramo Wooldridge Inc. AUTOMOTIVE GROUP** Serving the nation's manufacturers of cars · trucks · tractors · engines

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Ramco Division—Piston Rings; "Spirolox" and "Circolox" Retaining Rings. Address your inquiries to Thompson Products Ramco Division, Box 513, Dept. Q, St. Louis 66, Mo.

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ONLY FIRESTONE SEARCHES OUT ALL STRESS AND STRAIN TO BUILD THE WORLD'S STRONGEST RIM!

Firestone *Perma-Tite* Rims



Here's how Firestone's complete test program brings you built-in reinforcement at high-strain points to beat earthmover rim breakage! First, exhaustive Firestone laboratory tests chart the high-stress points caused by inflation pressure and loads. Analyses of these tests then allow Firestone Steel Products Company engineers to reinforce rim where extra strength is needed—insures Perma-Tite capacities far beyond the breakage limits of ordinary rims! Finally, thousands of hours of endurance and field tests double-check the laboratory results, prove Perma-Tite rims are the truest-rolling, strongest ever made! Perma-Tite's exclusive air seal and fusion-welding help add maximum strength and dependability to the rim. Specify Firestone Perma-Tite rims as original equipment, buy them as replacements. They're available for tubeless and tube-type off-the-highway tires.

SPECIAL PROTECTION against rust and corrosion for longer rim life, better tire performance.

INTERCHANGEABLE in complete units or by components with all earthmover rims and parts.

COMPLETE AIR SEAL insures retention of air at recommended pressures, delivers longer tire service.

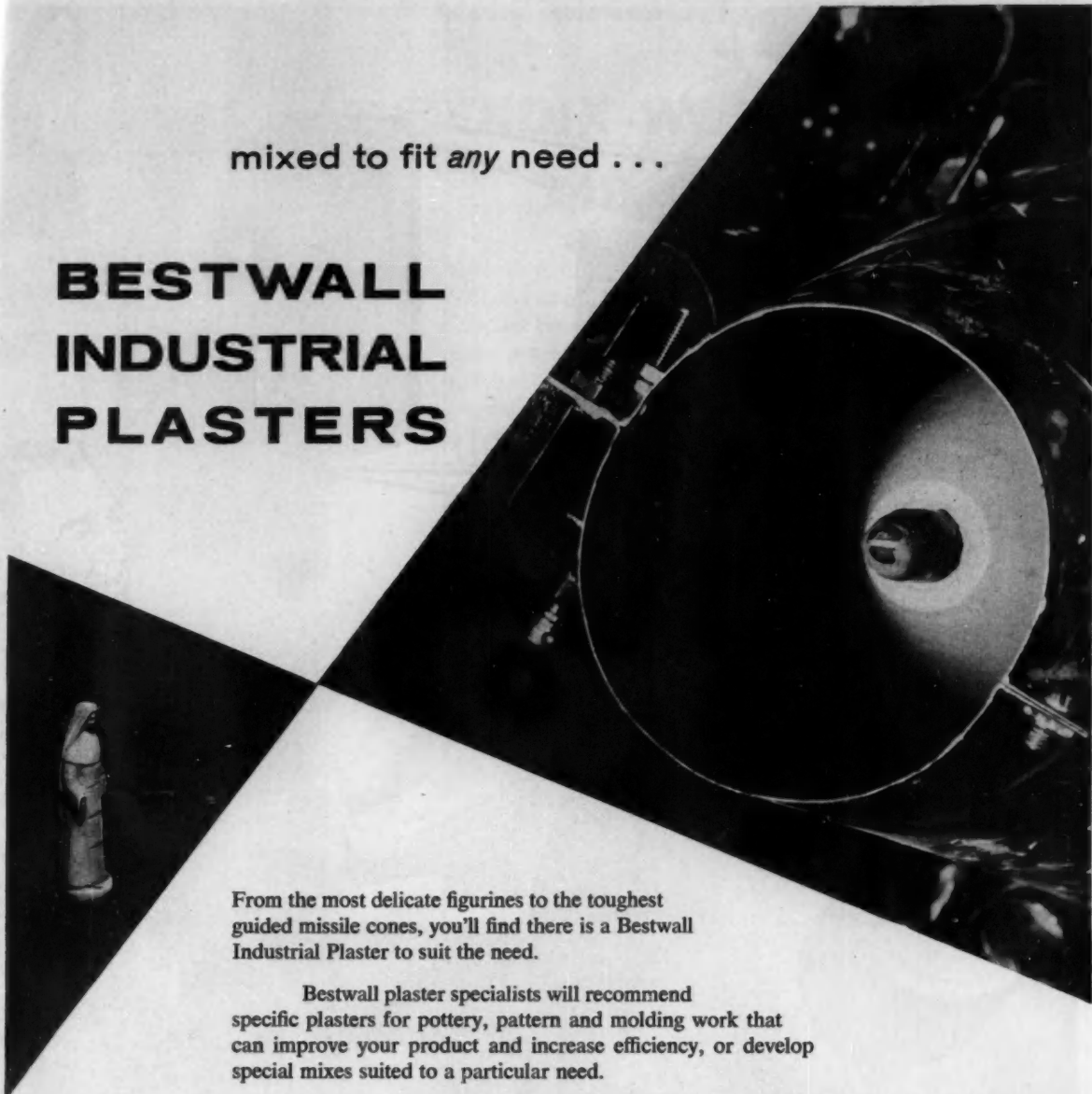
Specify Firestone Perma-Tite Rims for Peak Performance

FIRESTONE STEEL PRODUCTS CO. Akron 1, Ohio

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From the most delicate figurines to the toughest guided missile cones, you'll find there is a Bestwall Industrial Plaster to suit the need.

Bestwall plaster specialists will recommend specific plasters for pottery, pattern and molding work that can improve your product and increase efficiency, or develop special mixes suited to a particular need.

The basic line of Bestwall Industrial Plasters includes nine standard types covering a broad range of application. Special formulas are practically unlimited.

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SAE JOURNAL, SEPTEMBER, 1959



Reduce maintenance, lower GVW, add payload
with

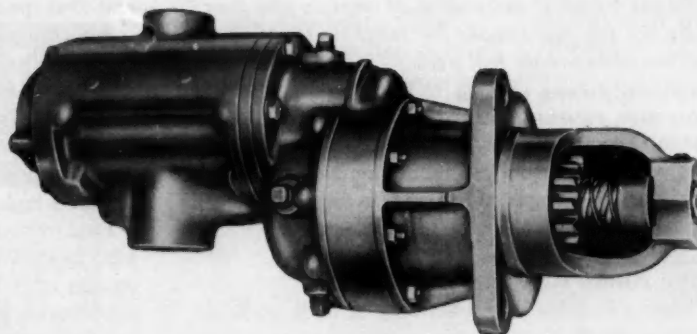
BENDIX-WESTINGHOUSE AIR STARTERS

You can reduce maintenance and add as much as 250 extra pounds of profit-making payload per run! Simply specify a compact Bendix-Westinghouse Startaire* air starting motor on your next new-vehicle order. You'll eliminate the weight and costly maintenance of heavy-duty batteries, oversized generators, switches and cables of an electrical starting system. With Startaire a light battery will suffice for all electrical needs giving you substantial savings on battery recharging and replacement costs.

Designed for use on air-brake-equipped vehicles, Bendix-Westinghouse air starting motors give gasoline or diesel engines fast-action, trouble-free starts under all weather conditions. A dependable Bendix-Westinghouse compressor provides an ample supply of compressed air for both the starting and stopping systems.

So whether you're starting a vehicle—with a Bendix-Westinghouse Startaire . . . or stopping it—with a Bendix-Westinghouse Air Brake system . . . you can rely on the Bendix-Westinghouse reputation for high quality, dependability, long life. Call us today, or write for full information on the money-saving, profit-making Bendix-Westinghouse Startaire.

*REG. U.S. PAT. OFF.



Two Startaire models available for all engine sizes: moderate duty for cranking engines up to 1100-cu.-in. displacement; and a heavy-duty model for engines over 1100 cu. in.

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WHY BUY METAL YOU DON'T USE?

Switch to Allegheny Ludlum Cast-to-Shape Tool Steel



FORGING

Stepped-out forging for fabricating spinning cone: 2300 lbs.—\$2691 material cost plus cost of machining.



CAST-TO-SHAPE

Cast-to-shape spinning cone 1059 lbs. \$860.97 Includes cost of the pattern.

\$1,831 Saved by changing to Cast-to-Shape

Why pay for metal that ends up as chips on your floor? Here are two fine reasons for switching to Allegheny Ludlum cast-to-shape tool steels.

CAST-TO-SHAPE MEANS YOU BUY FEWER POUNDS OF METAL.

Because the tool you buy is closer to its finished shape, you obviously spend less money on original metal. In the above example, the savings in metal cost alone amount to \$1,894.

CAST-TO-SHAPE MEANS LESS FINISH MACHINING.

A casting like that above has only $\frac{1}{4}$ to $\frac{3}{8}$ inches of machine stock on all surfaces, requiring very little machining compared to solid chunks. Cast-to-shape tooling is especially economical when working with intricate shapes.

Allegheny Ludlum, a tool steel producer who makes

cast-to-shape materials, casts them with the same precise quality control for which their tool steels is known. A full line of cast-to-shape tool steel grades is available. You'll find ones with high resistance to abrasion, compressive strengths of approximately 400,000 psi, easy machinability, hardening with almost no distortion, toughness, high red hardness, and the capacity to take a high polish.

Find out now how you can cut costs on your complex tools. Write for FC-4, a 28-page technical discussion of A-L's Forging and Casting Division with applications, pattern information, design tips, analyses, and heat treating instructions. Or call your nearest A-L tool steel warehouse or distributor.

**ALLEGHENY LUDLUM STEEL CORPORATION,
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ALLEGHENY LUDLUM

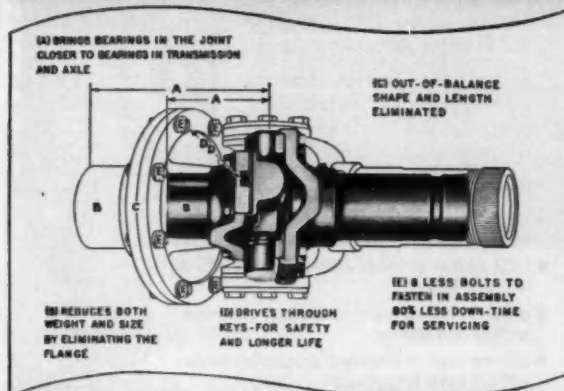
Tool Steel warehouse stocks throughout the country . . . Check the yellow pages
EVERY GRADE OF TOOL STEEL . . . EVERY HELP IN USING IT



$$\frac{\text{MECHANICS}}{\text{LESS PARTS}} = \frac{\text{LESS}}{\text{ASSEMBLY TIME}} + \frac{\text{LESS}}{\text{WEIGHT}}$$

$$\frac{\text{MECHANICS}}{\text{LESS WEIGHT}} = \frac{\text{MORE}}{\text{PAYLOAD}} \times \frac{\text{HAULS MADE}}{\text{BY TRUCK}}$$

You Are PAYING For MECHANICS JOINTS



Why Not Give YOUR Truck MECHANICS Advantages?

Every time you use a joint that requires unnecessary attachments and extra assembly time and labor, you are paying for MECHANICS Roller Bearing UNIVERSAL JOINTS advantages—but are not getting the benefit of them. And you are forcing your truck to carry unnecessary DEADWEIGHT that should be devoted to PAYLOAD.

MECHANICS Roller Bearing UNIVERSAL JOINTS eliminate the need for companion flanges—without sacrificing ease of assembly.

By taking full advantage of the MECHANICS design, a substantial weight reduction can be accomplished—at a point where fewer parts, minimum weight and faster assembly represent competitive advantages.

Let our engineers show you how this and other MECHANICS Roller Bearing UNIVERSAL JOINT features will benefit your new or improved models.

MECHANICS UNIVERSAL JOINT DIVISION

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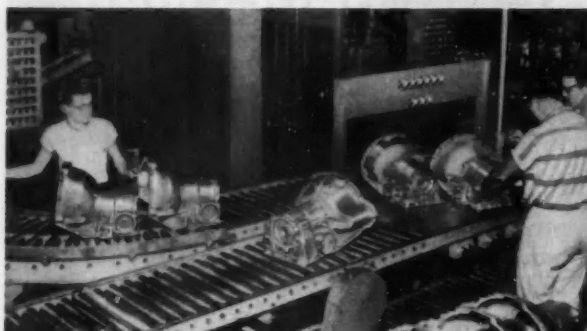
MECHANICS

Roller Bearing 

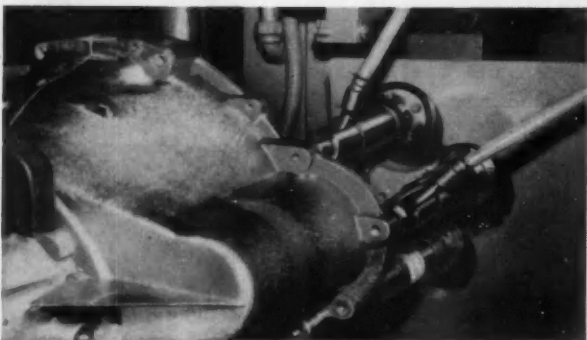
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For Cars • Trucks • Tractors • Farm Implements • Road Machinery •
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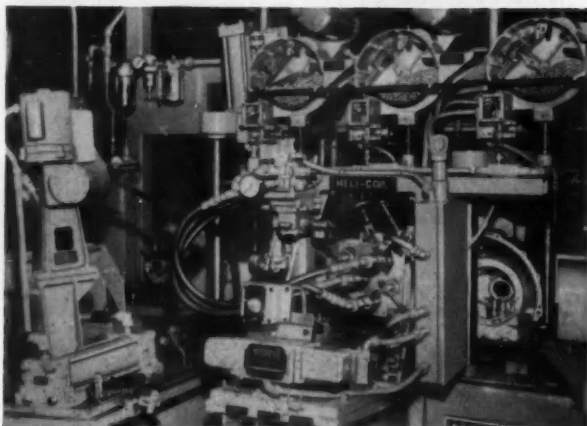
FORD Aluminum Transmission Housings get permanent steel thread strength with **HELI-COIL**® Screw-Thread Inserts



Aluminum housings are drilled and tapped, then transferred to Heli-Coil inserting machines on Ford assembly line. Each machine automatically and simultaneously installs three 5/16-18 Screw-Thread Inserts in seconds.



Inserts are picked up by air-powered rotating mandrels and wound into housing.



Hoppers over the inserting machine have 1500 insert capacity. Air jets speed inserts as they slide through nylon tubes into the inserting tools. Unit was specially designed and built by Heli-Coil Corporation as an integral part of the Ford production line and is the first completely automatic inserting machine to have all operations co-ordinated into a single unit.

Automatic Inserting machines speed installation on production lines

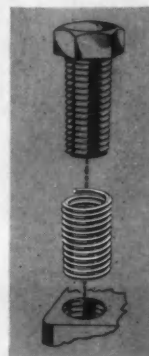
Tapped threads in the starter mounting pad of this new Ford aluminum transmission housing would have been too soft to resist wear caused by vibration, impact and occasional dismantling for service.

Ford Motor Company uses one-piece Heli-Coil Screw-Thread Inserts for greater thread strength under dynamic and static loading. With these precision-formed steel wire threads, there's no chance of thread wear or stripping for the life of the transmission.

Heli-Coil engineers designed and built high-speed equipment to install the inserts *automatically* right on the transfer line. There's no production slowdown.

Heli-Coil Inserts

- allow repeated assembly and disassembly without loss of thread strength
- hold screws or studs securely under vibration and impact
- prevent thread wear, stripping, corrosion, galling and seizing
- can be used in standard proportion bosses without need for redesign
- are available in a complete range of U.N.C. and U.N.F. thread sizes as well as spark plug and pipe thread series
- save assembly time, space, weight and cost.



HELI-COIL CORPORATION
DANBURY, CONNECTICUT

HELI-COIL CORPORATION

3609 Shelter Rock Lane, Danbury, Conn.

Send complete design data on Heli-Coil Screw-Thread Inserts.

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IN CANADA: W. R. WATKINS CO., Ltd.
41 Kipling Ave., S., Toronto 18, Ont.



Earl D. Wood, Vice President, Equipment and Maintenance, left, and L. R. Peterson, Chicago Maintenance Superintendent, examine one of General Expressway's new International Model DCOT-405 Tractors equipped with Fuller R-96 ROADRANGER Transmissions.

Geared by FULLER . . .

General Expressways gets five-star service from ROADRANGERS

General Expressways, Inc., Chicago, recently purchased 125 International Model DCOT-405 Tractors equipped with 220 hp diesel engines and 10-speed Fuller R-96 ROADRANGER Transmissions.

A major reason General Expressways specified the semi-automatic, single-stick ROADRANGERS was the excellent record of the 8-speed R-46 ROADRANGERS in the company's older International Model RF-195

and VF-195 Tractors. Placed in service in 1956, 43 of these tractors—used primarily on routes between Chicago and Cleveland—accounted for approximately 120,000 miles *per week*.

Earl D. Wood, Vice President, Equipment and Maintenance, says: "We get a lot of tough, high-mileage service from the R-46 ROADRANGERS in our older tractors. Maintenance costs have been low and, because engines work in the peak hp range at

all times, fuel economy is very satisfactory and average road speeds are up. Our drivers like the closely spaced forward ratios of the ROADRANGERS, as well as the fact that, with 1/3 less shifting, driver fatigue is reduced. We will continue to specify ROADRANGER Transmissions on new-equipment purchases."

Ask your dealer about the Fuller ROADRANGER best-suited to put more profit in *your* operation.

FULLER

TRANSMISSION DIVISION
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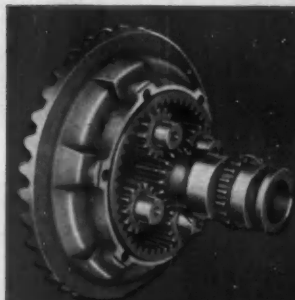
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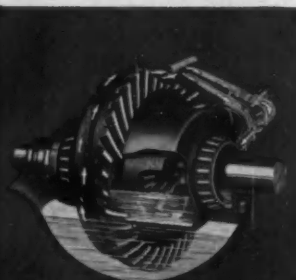
PLANETARY GEARING

—distributes wear over four rugged, slow-moving planetary gears, resulting in lower unit stress, reduced maintenance, and longer axle life.



FORCED-FLOW LUBRICATION

—supplies positive lubrication to all moving axle parts, even at slowest vehicle speeds. Reduces wear; cuts repair bills.



SELF-CONTAINED AIR BRAKE

—makes quicker, safer stops. Simple design with fewer parts cuts relining time. Available on Eaton air brake models.



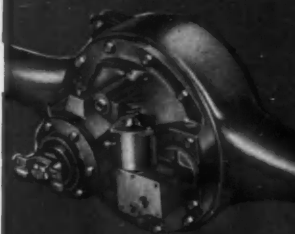
POWER SHIFT CONTROL

—provides quick, easy shifts. Drivers use right ratio for road and load; take full advantage of 2-Speed benefits.



EXTRA-RUGGED CONSTRUCTION

—of housing and all moving parts eliminates the possibility of harmful distortion or misalignment under full load; holds maintenance to a minimum.



INDUCTALLOY AXLE SHAFTS

—made of alloy steel, with Eaton's exclusive method of dual-hardening truck shafts; last up to 10-times longer; keep trucks on the road.



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It is not indestructible, of course, but it comes closer to this ideal characteristic than any other metal commercially available. What's more, it resists heat, rust and corrosion, and will not peel. These advantages may seem too obvious to mention—yet they are the very reasons why so many people who design, create, or buy things to endure insist on stainless steel. Nothing lasts so beautifully! And remember: The very best stainless steels are made with Vancoram Ferro Alloys.

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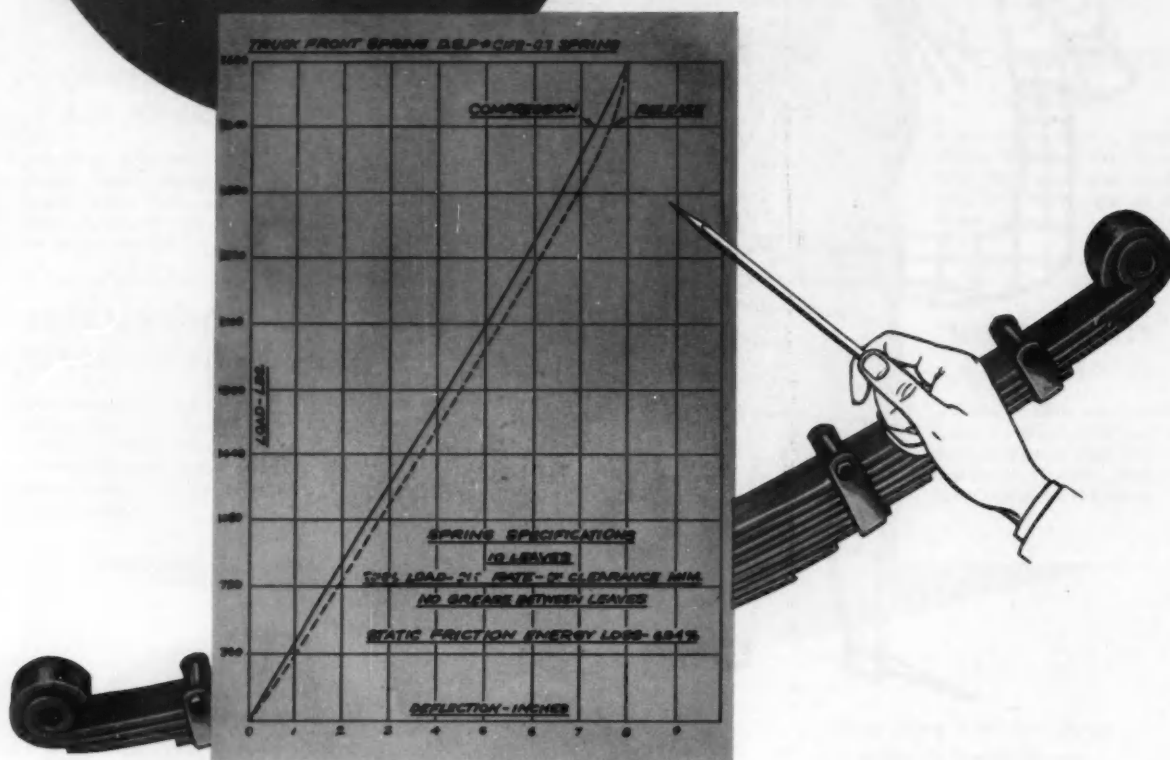


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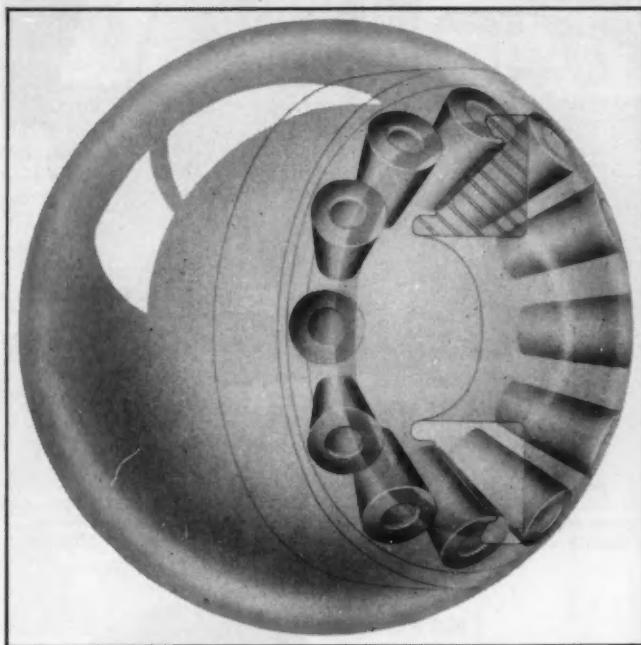
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One in a series of technical reports by Bower

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SPHERICITY — ESSENTIAL TO MAXIMUM BEARING PERFORMANCE



For a tapered roller bearing to achieve maximum performance, i.e., maximum life and capacity under load, it must have true sphericity — a condition of bearing geometry which permits true rolling of the tapered rollers in the raceway.

True rolling in tapered bearing elements is the result of maintaining a critical geometric relationship between the raceways and the contact surfaces of each roller. True rolling is essential to maximum performance. Without it, premature bearing failure is certain.

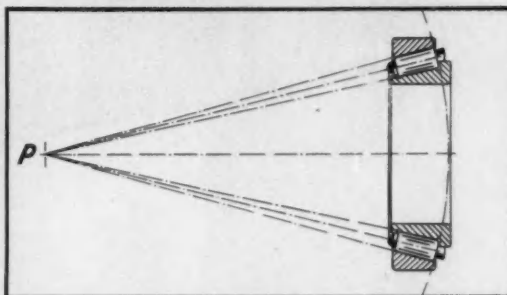
As engineers know, a tapered roller will describe a true circle when rolled on a plane surface. It will always roll in this one path precisely, without sliding or skewing. But to put true rolling to work in a bearing which can carry both heavy thrust and radial loads, it is essential that the rollers and the raceway have a true

spherical radius, or sphericity. The drawing illustrates this condition.

If each roller in the bearing were to be extended in length, while retaining its taper, it would form a cone, terminating at point "P". All cones generated from all rollers would meet at point "P", which is also the center of the hypothetical sphere shown. The surface of the sphere would touch all points on each roller's head!

In effect, then, each roller's taper determines the radius of a hypothetical sphere

When you require bearings, we suggest you consider the advantages of Bower bearings. Where product design calls for tapered or cylindrical roller bearings or journal roller assemblies, Bower can provide them in a full range of types and sizes. Bower engineers are always available, should you desire assistance or advice on bearing applications.



True rolling of tapered bearing elements depends upon maintaining a true spherical radius during manufacture.

whose surface, in turn, determines the correct contour for each roller head. Only when these conditions are satisfied in design, and when they are rigidly held during manufacture, will true rolling take place. In the manufacture of each Bower tapered roller bearing, sphericity is held within extremely narrow limits by means of special Bower-designed precision grinders. The consistent accuracy possible with these machines is one major reason why Bower roller bearings provide maximum performance under all speeds and loads up to the bearing's maximum rating.

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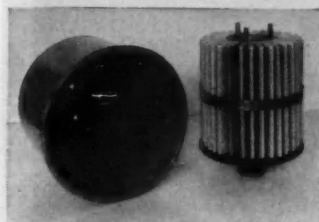
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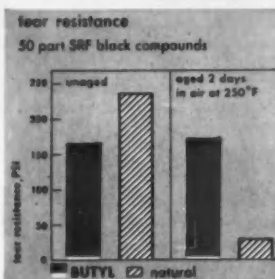
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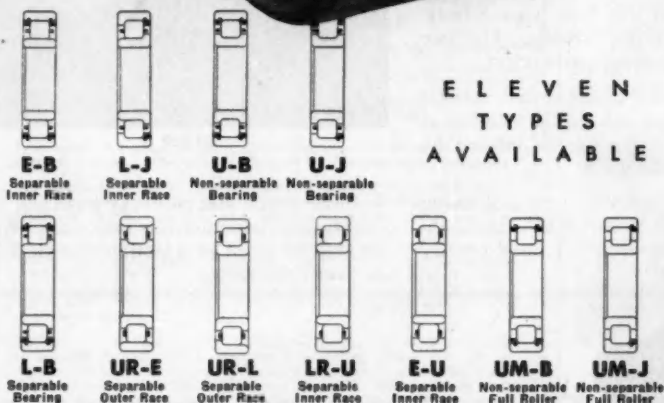
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↑ STEP 1



STEP 2 →

*Case History: Making
Hub-cap Embossing Dies*

SILASTIC RTV Molds Strip Fast and Easy

Silastic® RTV, the Dow Corning liquid silicone rubber that vulcanizes at room temperature, provides a new and better way to make prototype parts. This fluid rubber is easily poured into, over, or around complex shapes, and sets up in a short time. The result is a strikingly accurate mold, into which you can pour many casting materials such as plaster, waxes or plastics. Because Silastic RTV will withstand temperatures up to 500 F, many molten metal alloys can also be cast. Silastic RTV strips readily from most materials without loss of pattern detail. Here's how one automotive industry supplier — Cadillac Stamp Co. — uses Silastic RTV to make templates for hubcap embossing dies.

Step 1. A wood pattern was machined to the exact configuration of the hubcap design. The intricate design requires a material that releases easily without loss of detail. Silastic RTV has been poured on the pattern to make a "negative" mold.

Step 2. The Silastic RTV mold is then used to cast a plastic. A "positive" image that faithfully reproduces the original pattern results. This image forms a template or prototype from which a pantograph-type engraving machine can sink dies.

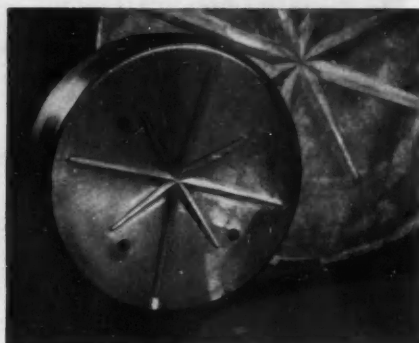
Step 3. Now we return to the rubber mold, and this time more Silastic RTV has been poured into it. A rubber "positive" results. The two rubber molds release readily and two exactly matching parts result.

Step 4. From the rubber "positive", another plastic image is cast. Silastic RTV strips off easily . . . a crucial factor. The second plastic template is now ready for the engraving machine to sink dies. Size is reduced by one-half in the process. Note size of finished hubcap.

Step 5. Here are all the steps reassembled. Remember — both embossing dies were made from one wood original, thanks to Silastic RTV. Throughout the process there has been no loss of pattern detail . . . and exactly matched dies have been made.



STEP 3



STEP 4



STEP 5

Is there a way that this easy handling and faithful reproduction can help you? We'll be glad to assist in adapting Silastic RTV to your operations.

Free Sample. Write on your letterhead for data and sample of Silastic RTV.
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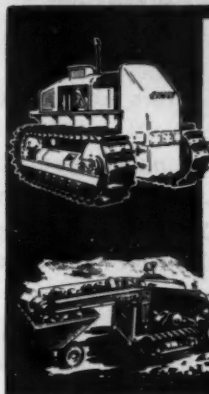
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June 15, 1959

For further information please write

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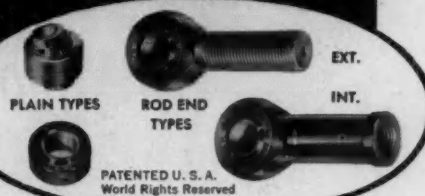
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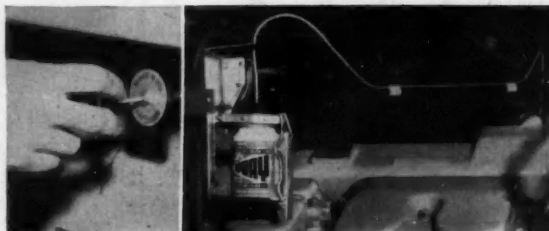
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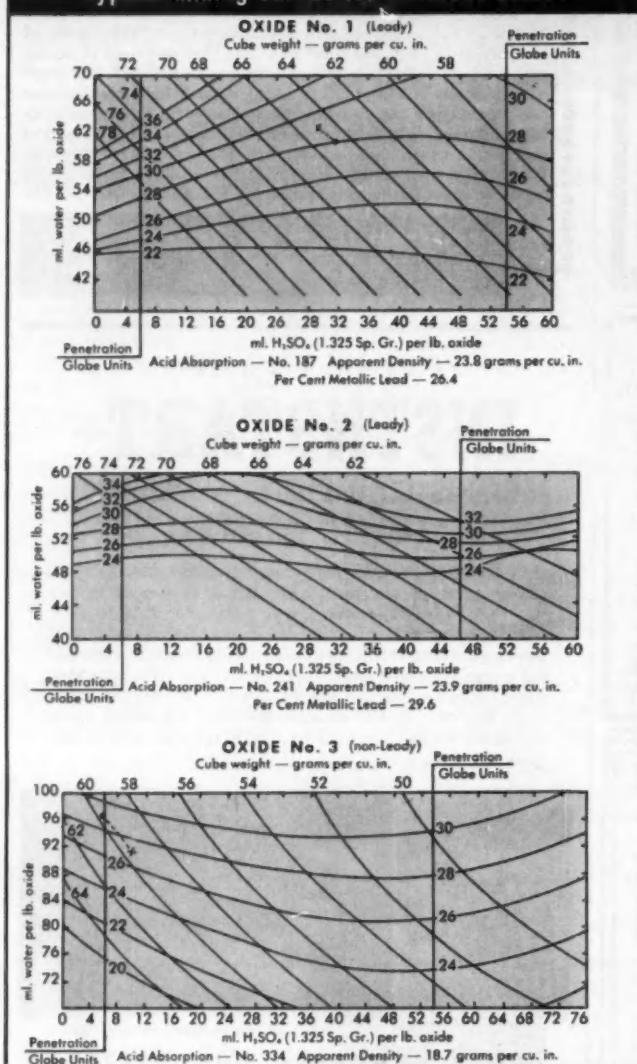


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from GLOBE Research

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Typical mixing curves for different oxides



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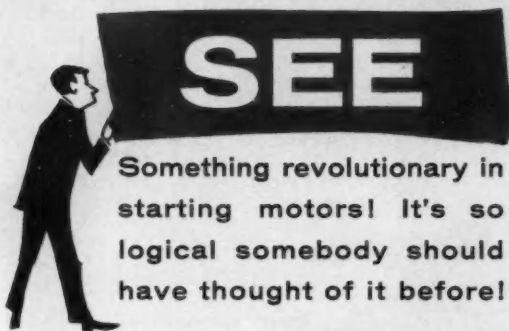
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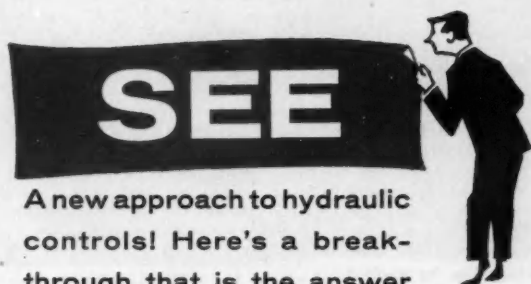
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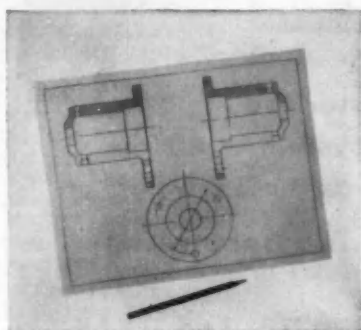
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Shiny Back vs. Pencil Back

A basic question is: do you need a double-surfaced drafting film? We make HERCULENE Drafting Film both ways, of course—with a single surface (shiny back) and double surface (pencil back). It's our recommendation that you use pencil back HERCULENE only if it's your practice to make basic drawings on one side, changes on the other. For most other uses, shiny back is preferable. (At first, the double-surface film was chosen by many drafting rooms because it lay flatter on the board than shiny back. This is no longer true. K&E research labs have come up with a fully effective anti-curl treatment.) Especially in filing, shiny back HERCULENE presents fewer problems. The clean non-abrasive back won't smudge the face of the sheet underneath, even in a heavy stack of tracings. If you'd like to compare a few sheets, please let us know.



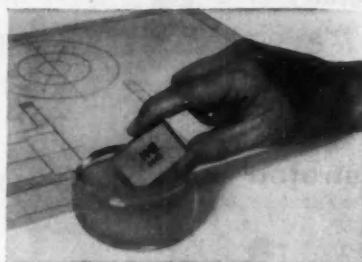
Note sharp clear lines made by Duralar pencil on HERCULENE Drafting Film.

Plastic Pencils and the HERCULENE Surface

Not just a handy catch-phrase, when K&E puts its exclusive "engineered surface" on a drafting material, the result is an exact, uniform tooth for sharp pencil drawing, inking and typing. With HERCULENE Drafting Film, however, an entirely new type of plastic (non-graphite) pencil yields especially good results. Quite a few of our customers have reported favorably on the well-known Staedtler "Duralar" brand. Duralar pencils come in five hardnesses, are non-smudging and have generally good covering power, sharpness and erasability. After about 20 prints, the Duralar lines show up consistently better than those made by a regular pencil, since graphite lines tend to lose density.

Wet That Eraser!

The erasing qualities of HERCULENE Drafting Film are excellent, but (as with the pencils) we've discovered it's a new type of vinyl eraser that gives the best results. Examples of these non-rubber type erasers are the Richard Best "TAD" and the Eberhard Faber "RACE KLEEN"—both available from your K&E dealer. With vinyl erasers, pencil lines whisk off. Even stubborn ink and typing can be removed easily, with no damage to the surface. Here's a tip on how to do this:

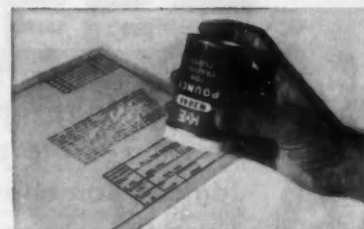


Moisten the eraser slightly. It becomes no more abrasive, but a lot more "erasive." Moistening is a must when removing Duralar lines or typing after exposure to heat. (Incidentally, don't use electric erasing machines, steel erasers or typewriter erasers.) When erasing large areas, certain chemical eradicators work fine too. Our suggestion: use Vythene or a very light application of a denatured alcohol such as Solox, both of which can be applied with a cotton swab or clean cloth.

The Cleaner the Better

HERCULENE Drafting Film was designed for ink work, and its ink take is unexcelled. But like all films, its non-absorbency makes a few preparations advisable. The surface should be cleaned thoroughly before inking. Quickest and most effective way to do this is with the ABC Draftsman's Dry-Clean pad, which will remove finger marks and "traffic film" simply by rubbing the pad over the surface. Pouncing will also work well. A damp cloth is all right for general cleaning, but does not do the best job of preparing the surface for ink.

Inking over graphite pencil lines comes out best when done over light lines, drawn with a harder grade of pencil. A good way to remove excess graphite is to go over the drawing with an ABC pad. Inks vary in their usefulness on HERCULENE. We've tested several, and you're welcome to these results as well, on request.



After Typing, Please Pounce

Typed impressions on HERCULENE Drafting Film are crisp and sharp, but may take a while to dry because the film's surface doesn't "swallow" ink readily. A light pouncing right after typing will dry the ink and fix the lines—giving you uniform permanent contrast.

A new typewriter ribbon will produce the best impressions. At K&E we've tested a healthy variety of ribbons and we'd be pleased to send you the results on request.

Outstanding Advantages Proved in Tests

We're pleasantly amazed at the short time it took for HERCULENE Drafting Film to become an accepted "staple"—along with ALBANENE® Tracing Paper and PHOENIX® Tracing Cloth. Actually, it's a rare drafting room by now that has not tested HERCULENE during its first year on the market. The findings: All properties considered, HERCULENE stands up better than any other drafting film. It has great resistance to heat, aging and abuse. Its exclusive "engineered surface" plus its tough, durable Mylar® base provide superior pencil and ink take, fine erasability, remarkable dimensional stability...a combination we're proud to call unbeatable!

The K&E dealer near you has HERCULENE now. Stop in and see him.

KEUFFEL & ESSER CO., Dept. SJ-9, Hoboken, N. J.

Please send further information about HERCULENE Drafting Film. I'd like samples too.

Name & Title _____

Company & Address _____

2001



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